

WILD FLOWERS OF AMERICA.

WILD FLOWERS
OF
AMERICA.

WITH FIFTY COLORED PLATES, FROM ORIGINAL DRAWINGS

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Plate I.

WILD COLUMBINE.

AQUILEGIA CANADENSIS.

PLATE I.

WILD COLUMBINE.

Aquilegia Canadensis, L.

THE Crowfoot family to which this plant belongs is an order in which the different genera vary somewhat in the number of parts present in the flower, but which can be easily recognized, in most cases, by having all the parts separate from each other. A few plants of the order are slightly woody, clematis and tree peony, for example: the others are herbs, as is the one in the plate.

The Wild Columbine is one of a dozen species of the genus *Aquilegia*. It is a native of the eastern part of the northern United States. Two species found beyond its western limit were formerly confounded with it, but are now separated under the names *Aquilegia formosa* and *Aquilegia truncata*. The first of these occurs in the Rocky Mountains, and its range extends northwestward to Oregon and Alaska; the other species belongs to California.

The Wild Columbine was made known to European gardeners in the middle of the seventeenth century. It appears to have been first described under the name *Aquilegia pumila præcox Canadensis* on account of its diminutive size, its early flowering, and its home. The plant grows wild on

ledges or rocky slopes where the soil is scanty. It blooms from April to June.

The genus has a wide geographical range through temperate regions. Among its more showy sorts are the Siberian and Alpine species, and the large flowered purple, and yellow columbines of the Rocky Mountains. All the species are very patient under cultivation and grow even where the ground is poor, but they thrive best in rich soil.

Wild Columbine is about twelve or fifteen inches high, but a late variety, flowering in shady places the last of June, often reaches the height of two feet or more. Usually, a few stems and several root-leaves rise together from a shortened underground stem, and thickened root. The stems have a few slender branches, at the tips of which the flowers are suspended.

The leaves are composed of three roundish, three-lobed, sparingly cut leaflets. The root-leaves are on long purplish leaf-stalks or petioles.

The flowers in this genus are complete¹ and regular. There are five ovate or oblong sepals somewhat spreading and early falling off. The five petals alternate with the sepals. Each petal is a slender, tapering tube closed at its tip, and there holding a drop of nectar, but attached by the inner margin of its oblique and flaring lip to the receptacle, or end of the flower-stalk. In the Wild Columbine the

¹ The different organs of flowers will be described, and the terms applied to them explained, in a note at the end of this paper.

spur-like petals or nectaries are almost straight, but in the well-known Garden Columbine of Europe they are hooked at the point. This distinction between a new-world and an old-world species is general; the old-world sorts have hooked or sharply curved spurs; those found in America have them nearly or quite straight.

The stamens are numerous and obscurely grouped together into five or ten clusters, with long and thread-like filaments, but some of them are without anthers, and therefore abortive. The latter are generally the innermost and are not unfrequently reduced to membranaceous scales. The anthers are two-celled and open lengthwise on the sides.

The pistil is composed of five carpels, sometimes one or two more or less, long and narrow, and closely appressed to each other, and each crowned by a slender style, down the inner side of which the stigma extends for a short distance. Within are the numerous ovules, arranged in two rows along the inner angle. These carpels ripen into cylindrical pods which split open at maturity down the inner side, exposing the smooth and shining seeds.

The flower buds and newly opened blossoms hang inverted from the slender drooping flower-stalk, which when the flower is fading begins to straighten slowly, and at the period of maturity of the fruit has become nearly erect and quite rigid.

The showy flowers are visited by many kinds of insects in search of nectar. Some insects find that the nectar at the end of the spur lies out of their reach and cannot be ob-

tained by them through the open mouth of the tube. In such cases they puncture the side of the spur and extract the nectar through the aperture. Certain western species of Columbine, which have remarkably long spurs, are more frequently robbed in this way than our shorter spurred kinds, where the nectar is easily accessible through the mouth of the petal. It is not yet quite clear in what way the visiting insects aid in the fertilization, but there is good reason for believing that they carry pollen from younger flowers to the stigmas of the older blossoms. The explanation given by Dr. Hermann Muller (*Die Befruchtung der Blumen durch Insekten*, p. 118), may be given at length.

“The sepals of the inverted flowers are developed as broad colored blades, and therefore contribute to the attractiveness of the blossoms. Each of the petals is prolonged upward into a hollow spur, the funnel-shaped entrance of which is so wide as easily to admit the head of a humble-bee, and its narrow tube, bent inward and upward, contains in the curved tip the nectar which is secreted from the fleshy thickened tissue at that point. The humble-bees, in order to get at the nectar, hang on the under side of the flowers in such a way that they hold with the forefeet the base of the spur, and grasp with the middle and hind feet the column which is formed of the stamens and pistils, while the head is thrust as far as possible into the throat of the spur, and the extended proboscis follows its curvature. Since the bees can very easily and conveniently bend the tip of the proboscis downward, but can turn it the other way only with difficulty, the above-described position is the only one in which the bees can conveniently reach the nectar. It necessarily follows that the bees will be dusted beneath with pollen

from the younger flowers, where the still closed styles are concealed by the stamens, and upon visiting the older flowers they will dust with this pollen the stigmas of the now somewhat divergent styles, and cross-fertilization of older by younger flowers must unavoidably take place.

It may be interesting to compare with this, the remarks of Conrad Sprengel in 1793, on the same subject.

“*AQUILEGIA VULGARIS*. The fleshy end of the nectaries secretes nectar, but this liquid cannot flow out of them, for it occurs in the uppermost curve portion, and is too strongly adherent to it. That no rain can reach the nectar is seen at a glance. . . . The flower is visited by large humble-bees, and I have also found other bees on it. They first collect the pollen from the anthers, but instead of then creeping into the nectaries they betake themselves to the outside, and bite a hole in the very tip of the nectaries and extract the nectar through it. Leske pretends, according to Medicus, to have perceived in this flower also the so-called *wandering* of the stamens to the pistil. But in this he is quite mistaken. It is true that the innermost row of stamens touches the styles with its mature anthers, and the other rows follow in succession. But when this happens the styles are shorter than the filaments and lie closely appressed together. It is only after all the stamens have shed their pollen that the styles are prolonged, finally becoming longer than the stamens were, and curving outward so that the stigmas are separated from each other. . . .

“*AQUILEGIA CANADENSIS*. Here, it is true, the end of the nectary is not much curved but only a little bent; nevertheless, the nectar cannot flow out, because the long thin tube attracts it too strongly. This beautiful flower has a nectar-guide; for the corolla is red, but the

lower, broader part of the nectaries is yellow, especially inside." *Das entdeckte Geheimniss der Natur*, p. 279.

The curved nectaries of Garden Columbine bear a remote resemblance to the talons of a bird of prey, and it has been thought by many that this suggested the generic name *AQUILEGIA*, from *aquila*, an eagle.¹ Others have supposed the derivation of the word to be *aqua* and *lego*, "to collect water," perhaps in the rolled up and unfolding leaves.² The application of the common name Columbine (from *columba*, a dove) is likewise doubtful. In many works it is referred to the bird-claws of the blossom, but a painstaking writer, Mr. Prior, states that it was given on account of "the resemblance of the nectaries to the heads of pigeons in a ring round a dish, a favorite device of ancient artists."³

NOTE.

A flower is conceived by botanists to represent a bud which has developed in a peculiar manner. Instead of growing into a leafy branch it has given rise to a shorter axis, around which certain parts answering to leaves and considered as modifications of them, are closely but symmetrically clustered. These parts are the floral organs and are of two kinds; the outer organs, in part for protection, are termed the envelopes; the inner, wholly for reproduction, are called the essential organs. These parts are arranged in circles or sets, in a complete blossom four in number.

¹ "Aquilegia, ut aiunt, ab Aquila nomen fluere patiatur." Cornuti, *Canad. Plant. Hist.*, p. 61.

aduncis referre existimatur." Tournefort, *Institutiones rei herb.* ed. 11, p. 430.

"Aquilegia dicitur, quod aquas legat, folia-
que dum crescunt et in se convolvuntur, aquas
colligant." Morrison, *Hist. Plant.* III, p. 457.

² Quod hæc planta, initio dum crescit non-
dum explicatis foliis, et nubilo die convolu-
tis in sese, per imbres aquas colligat nec de-

³ *The Popular Names of British Plants*,
ed. 2, p. 51.

The outer circle is made up of *sepals*; these, distinct or coalescent, constitute the *calyx*. Within this is a second circle of protecting organs, the *petals*, which make up the *corolla*. These organs are usually, but by no means always, the most highly colored part of the flower. The *essential* organs, so termed because it is alone through them that seed can be perfected, are of two sorts; the outer, the *stamens*, generally in two circles making up the *andræcium*, and surrounding the innermost, the *pistil*, which is to be the receptacle of the perfected seeds. Each stamen consists of an *anther* and the *filament*, or supporting stalk, which may be extremely short or even wanting. The anther is a sac filled with *pollen*, generally in the form of dust, shown by the microscope to consist of minute grains of characteristic shape, size, and markings. The pistil is made up of one or more *carpels*, distinct, or more or less completely blended together, and usually comprises three parts, the *ovary*, holding the ovules, the *style*, surmounting the ovary, and the *stigma*, a point, or knob, or line of sticky surface at the side or summit of the style. The style may be wholly wanting. When the pollen acts upon the stigma, each grain may send down, after a time, a slender tube which at last reaches an ovule. Here the contents of the tube blend with the contents of a cell or a group of cells in the ovule, in which a new development commences, culminating in the production of an embryo plant. The ripened ovule is a *seed*; the ripened ovary with its contents, and often with some of its contiguous parts adherent, constitutes the *fruit*.

A *complete* flower has all the sorts of organs present; namely, stamens, pistil, petals and sepals; a *regular* one has all the organs of each set of the same shape and size.

In the descriptions which are to accompany this series of plates, the numerous variations in the structure and form of the flower will be pointed out.



PLATE II.

SLENDER GERARDIA.

Gerardia tenuifolia, Vahl.

DOWNY FALSE FOXGLOVE.

Gerardia flava, L. in part. (*Dasystema pubescens*, Benth.)

THESE plants, so dissimilar in appearance, differ likewise in structure,—so much so that they have been referred to separate genera; but they are now assigned by the best authorities to the same genus, *Gerardia*. They belong to the Figwort Family, or *Scrophulariaceæ*, the characters of which may be more fully given in subsequent numbers of this work. Slender *Gerardia* is an annual, a foot or more in height, with a diffusely branched stem, opposite branches, and entire, narrowly linear, acute leaves. The flowers are single, on slender flower-stalks which spring from the axils of the upper leaves. The calyx is free, bell-shaped, with five acute, but very short teeth. The purplish corolla is likewise bell-shaped, with a border irregularly five-lobed, the two upper lobes smaller than the others. The stamens are four and in pairs, the lower pair longer than the upper, but both shorter than the tube of the corolla; the filaments are hairy; the anthers have two parallel cells pointed at the base and covered with white

woolly hairs. The pistil is composed of two coalescent carpels forming a two-celled ovary with numerous ovules in each cell. The ripened ovary or capsule is globose and equal to or shorter than the calyx. The plant blooms in August and September.

The other and larger plant, Downy False Foxglove, is a perennial, with opposite leaves on an almost simple stem, which is terminated by a showy few-flowered spike of yellow blossoms. The stem is two to three feet high and densely covered with a soft down, or pubescence. The lower leaves are two to five inches long and a quarter as wide, narrowed at their base into a short leaf-stalk. These leaves are more or less lobed or toothed, often irregularly, except the upper ones, which are for the most part entire. The lower leaves are generally narrower in proportion than the upper. The flowers are opposite, single, on very short flower-stalks in the axils of the upper leaves. The free calyx is cut into five oblong, obtuse segments, which may themselves be toothed. The bright yellow corolla is trumpet-shaped, with five nearly equal spreading lobes, and has a long tube which bears on the inside soft short wool. This down covers the filaments and at first the anthers. The presence of this wool gave the name to the genus to which this plant was formerly assigned, namely *Dasystoma*, which is from the Greek for *woolly-mouth*. The four stamens are attached to the corolla in pairs as in Slender Gerardia, but the filaments are somewhat longer, and the anthers have conspicuous awns or

points at the lower part of each cell. In both species of *Gerardia* the style is long, enlarged at its tip to form the stigma, and curves across the entrance in such manner that a bee or other large insect could hardly enter the flower without brushing against it. The fruit is an ovate, pointed, two-celled capsule with numerous irregularly angled seeds. The flowers open in July and August.

Müller explains the cross-fertilization of plants kindred to these, as follows: the tip of the protruding style is of course touched by the body of a visiting insect, before the anthers can be reached; if the body of the insect has previously received pollen from another flower of the same species, this will be deposited on the stigma.

The pollen of *Gerardia* is very dry, and at maturity of the anther is thoroughly distributed among the hairs which clothe the filaments.

Some of the species of *Gerardia* have been shown to be partially parasitic. Plants which derive their food wholly from other living organisms are known as parasites. They are generally white or whitish, owing to the partial or entire absence of "leaf-green," or chlorophyll, the efficient agent in vegetable assimilation. There are some parasites which obtain only a portion of their nourishment thus at second hand; they possess more or less leaf-green and are able to assimilate inorganic matter; but, at the same time, they attach themselves to the stems or roots of other plants and absorb elaborated juices from them. Such plants are called partial

parasites. There are several species belonging to the Figwort Family in which this partial parasitism has been clearly demonstrated. As in the case of the Gerardias, the foliage is green, and the appearance of the plants does not suggest that they are obtaining any of their food in a surreptitious manner. A few of the roots become attached to the roots or underground stems of other plants, and draw from them elaborated nourishment. Attention was first called to this fact in 1853, by Mr. Jacob Stauffer, of Mt. Joy, Lancaster Co., Penn. He found Downy Foxglove parasitic on the roots of white oak or witch-hazel, and *Gerardia pedicularia*, L. on the roots of grasses.

Professor Gray, in his notice of Mr. Stauffer's discovery, refers to the very curious fact that "the numerous branches of the root are not only attached by disks or suckers to the bark of the root of the foster plant (in this case either white oak or witch-hazel), but also are implanted upon each other, forming parasitical anastomoses."¹ That is to say, this parasitic plant fastens some of its thieving roots upon itself! Double parasitism like this is by no means uncommon. In the "Gardener's Chronicle" for August, 1874, an account is given of a mistletoe preying on a mistletoe! In *Gerardia*, the parasite appears to steal from its own plunder.

The mechanism of parasitism, as now understood, may be given in the words of Professor Sachs.

"The absorbing roots of parasites penetrate into the tis-

¹ *American Journal*, 1853, September.

sue of the host or foster plant, and often grow into it in the most intimate manner. It is certain that the exciting cause of the transport of the products of assimilation from the host to the parasite resides in the latter; the parasite acts on the conducting masses of tissue of the host like a growing bud of the host itself; the food materials penetrate into it because it consumes and changes them."

Professor Sachs further explains the absorption by partial parasites of food material from decaying organic matters from which water alone can extract nothing, by the hypothesis that the serviceable nutriment is first dissolved and chemically changed by the organs which stand ready to absorb it. If, therefore, vegetable matter is supplied to the roots of partial parasites, they are able to obtain some of their food from it.

Slender *Gerardia* and Downy False Foxglove grow in dry open woods, generally where there is abundance of vegetable mould. In cultivating the *Gerardias*, vegetable mould must be supplied freely, and the soil kept moderately moist.

The genus *Gerardia* commemorates the name of John Gerarde, a London surgeon, who published, in 1597, "The Herball, or General Historie of Plantes," a folio work of 1392 pages on plants and their uses.

The common name False Foxglove may need a word of explanation. It serves to distinguish the plant from true Foxglove, or the medicinal *Digitalis*. The name Foxglove, according to Mr. Prior, is derived "from Foxes-glew, or music, Anglo-Saxon gliew, in reference to a favorite instrument of earlier times, a ring of bells hung on an arched support."



PLATE III.

WILD CRANESBILL.

Geranium maculatum.

THIS plant grows at the edge of thickets and by roadsides, blossoming in New England from April to June, and ripening the fruit in July. The erect forking stem, from one to two feet high, is sparingly covered with stiff hairs. The leaves, which spring from the base of the plant, have long leaf-stalks, and are parted into three to seven segments, each of which is again parted or lobed irregularly. The stem leaves are smaller and less divided, and either have short leaf-stalks, or, in the case of the upper, none at all. The flower-stalks bear from one to three purple flowers. The separate flowers in a cluster often differ widely in the time of development, the bud and ripening fruit being found on the same flower-stalk.

The sepals and petals are five, and alternate with each other. The sepals are ovate, pointed, and somewhat hairy outside. The petals are broadly obovate, entire, and generally bearded with slender hairs on the lower part and edges of the short claw. The ten stamens are in two rows, somewhat united together by the base of the dilated filaments. The inner and longer filaments alternate with the petals, and

have behind them minute nectar-bearing glands. The anthers are two-celled, attached to the filament by the middle, and when mature open down the sides, the outer row opening first and the whole early deciduous.

The pistil is composed of five carpels with two ovules in each. The carpels are adnate to the prolonged axis as far as the insertion of the ovules, and above this are coalescent for a little way. The upper part of the style of each carpel curves outward slightly at first, afterwards much more.¹

The ovary ripens into a five-celled fruit, each cell becoming one-seeded by abortion.² At maturity each carpel, now ripened into a valve of the fruit, separates at its base from the axis and curves upwards, often elastically, with the concavity on the outside. The seed falls out from the fruit through a slit which runs along the angle on the inner side. Other plants of this family have even more striking provision for dissemination. In the allied genus *Erodium*, or Storksbill, the pod does not open to let the seed fall out, but according to Hanstein³ serves to fasten the seed in the soil.

¹ Hofmeister (*Flora*, 1864, p. 409) regards the canal of the style, down which a pollen grain must send its tube, as being in the axis between the inner angle of the carpels which are folded at their edges and laterally grown together. The canal of the style turns down as far as the point of insertion of the two ovules in each cell, and opens into each cell by a short cleft between the ovules. The upper part of each cell of the ovary is empty and is much prolonged upwards, parallel to the canal of the style.

² Only one ovule in each cell is fertilized. This becomes a somewhat three-sided seed, containing a curved embryo which is not unfrequently of a greenish color.

³ *Botanische Zeitung*, 1869, p. 530.

"Each of the pods or valves of *Erodium* is pretty long, and roundish near the base, where it is fastened by a point. At maturity, the outer side of each contracts by drying more strongly than the inner, and thereby causes an outward curvature and separation of the parts of the fruit. But the tissue of the awn or prolongation of the pod being hygroscopic, it extends again by absorption of moisture from the air. On further drying, the awn by more complete contraction on one side rolls up to form a perfect screw, whilst only the upper extremity bends out into a sickle-like curvature. If the fruit is fastened perpendicularly on a support, the curved end moves like the hand of a watch, sometimes backward sometimes forwards, with every change in the amount of atmospheric moisture, and on this depends the well-known application of these fruits in the construction of simple hygrosopes. The very large fruits of *Erodium gruinum* are especially adapted for this study. When drying, the fruit forms a left-handed screw, so that with increase of moisture the tip turns like the hand of a watch; by diminution of moisture it goes the other way. If one puts such a fruit, in a fresh and therefore extended state, on soil which is not too moist, the tip of the beak will describe at first a broad lateral sickle-like curvature, while in its lower part twisting begins. Supported on the curved upper end, the fruit rises and by means of its point gains a position which is inclined to the ground. By increasing torsion, it therefore penetrates the soil and straightway is fastened there, for it is wholly covered with little bristles which, being directed somewhat up, act like grappling-hooks. By further spiral movement the fruit goes more deeply into the ground, since the end of the awn fixed in a slanting direction against the ground can neither penetrate it nor yield. While thus one turn follows another, the spiral nearest to the head of the fruit bores into the ground like a corkscrew, and pushes the true fruit before it and more deeply down."

"If the whole is moistened afresh, the screw extends with dimin-

ishing torsion, but it cannot move back, since the whole under part of the awn is clothed thickly on its outer curvature with retrorse bristles, but must press the head of the fruit more deeply into the ground. As often, therefore, as moisture and dryness alternate, the fruits penetrate more deeply into the ground until the whole spiral disappears. Thus the hygroscopic tissue of the outer side of the beak of these fruits, which sometimes swells and sometimes contracts, appears to be an auxiliary apparatus for proper sowing."¹

Nearly the same phenomena may be studied in the fruit of the cultivated Pelargoniums.

The mechanism by which cross-fertilization is effected in the Geranium appears to be very simple. The stigmas are immature when the anthers discharge their pollen. According to Müller,² most of the large-flowered species of Geranium shed the pollen first from the outer stamens, next from the five inner ones, after which the styles become recurved and the stigmatic surfaces exposed.

It was this genus which first attracted the attention of Conrad Sprengel to the study of the relations of flowers to insects. The history of Sprengel's earliest observations, almost a century ago, is given in detail in a curious book by him which appears to have been wholly neglected until Mr. Darwin called attention to it within a comparatively recent period. The extract which is here given loses much of its quaintness by translation.

¹ *Botanische Zeitung*, 1869, p. 530.

² *Die Befruchtung der Blumen durch Insekten*, pp. 161-165.

“When, in the summer of 1787, I carefully examined the flower of Wood Geranium (*Geranium sylvaticum*), I discovered that the lowest part of its petals was provided on the inner side and on both edges, with fine, soft hairs. Convinced that the wise Author of nature has not made even a single hair without a definite design, I reflected upon the purpose which these hairs might serve. And it then occurred to me that if we suppose that the five drops of nectar, secreted from as many glands, are designed for the nourishment of certain insects, it might not be improbable that provision had been made to keep the nectar from injury by rain, and that these hairs are employed to attain this end. . . . Each drop of nectar rests on its gland immediately under the hairs which occur on the edges of two contiguous petals. Since the flower stands erect and is pretty large, it must catch rain-drops whenever it rains. But none of the drops which fall in can reach the nectar and mingle with it, for they are kept out by the hairs which cover it, just as the drops of perspiration which fall from the forehead are retained by the eyebrow and eyelashes and kept from getting into the eye. And yet an insect is not hindered in the slightest from reaching the nectar. I next examined other flowers and found that they had something in their structure different from the first, but which seemed to answer the same purpose. The further I prosecuted this investigation, the more plainly I saw that those flowers which possess nectar are so constructed that although insects can get to it, the rain cannot injure it. Thereupon I concluded that the nectar of those flowers is secreted chiefly for the sake of insects, and is protected against the rain so that they can enjoy it pure and uninjured.”¹

The name Cranesbill was given on account of the re-

¹ *Das Entdeckte Geheimniss der Natur*, 1793, p. 2.

semblance of the fruit with its prolonged beak to the bill of the crane. *Geranium* is derived from γέρανος, a crane.

Wild Cranesbill is sometimes called Spotted Cranesbill this being the translation of its systematic name. But although sometimes the older leaves are blotched with whitish spots, the discoloration is seldom sufficient to attract attention.

This plant was cultivated in Europe as early as 1732. It thrives best in rich mould, where it will sometimes reach a height of three or four feet.

The root and the thick part of the stem which is under ground are both very astringent and have been employed in medicine.

The so-called Geraniums in common cultivation are Pelargoniums. They have slightly irregular corollas, and a very slender spur attached so closely to the flower-stalk that it would ordinarily escape observation. They generally have seven stamens with anthers; instead of the ten which we find in the true Geraniums.¹

¹ It may here be observed that Wild Cranesbill, which has five sepals, five petals, ten stamens, and five carpels, is technically called a *symmetrical* flower. It has an equal number of organs in each circle; the stamens being in two sets, or circles, of five each.



PLATE IV.

WAVY-LEAVED ASTER.

Aster undulatus, L. *Aster diversifolius*, Michx.

THIS plant grows in dry thickets and about the borders of woods; it blooms in September and October. The stem is nearly simple, one foot and a half to three feet high, bearing a loosely branched pyramidal cluster or panicle of flowers. The species includes a great variety of forms, but they are all easily recognized by the leaves, which, from the base to the top of the stem, pass gradually from one distinct shape to another. The lowest or radical leaves are heart-shaped; they are borne on long leaf stalks with narrow margins, which are broader and clasping at the base. Those upon the stem are smaller and either lanceolate or ovate; they have short broadly margined leaf-stalks, or at the top none at all, in which case they clasp the stem by a heart-shaped base. On the branches the leaves are very small and sharply pointed. Most of them have wavy edges which are more or less irregularly toothed. The leaves are somewhat rough on the upper side, but softly downy on the lower. This pubescence, which is shared also by the stem, gives the plant a somewhat

dull or hoary aspect. The flowers require a special explanation. They are in clusters of flower-clusters; that is, each of the smaller clusters, with its circle of blue rays, and its surrounding series of green scales or bracts, is a head of many blossoms, easily mistaken for a single flower. This sort of compact flower-cluster was once called "a compound flower," and the erroneous name is now perpetuated in that of the order to which this plant belongs, *Compositæ*.

As a glance at the plate will show, the Aster has many such heads of flowers. They are erect, on short stems, and are loosely scattered along the branches. In order of development the upper ones are a little in advance of the lower. Each cluster consists of a large number of minute flowers borne on a flat disk, which is merely the broadened end of the flower-stalk. The central flowers are yellow, changing to dull purplish, and are nearly tubular; the outside fringe of blue is made up of flowers with ribbon-shaped or flat corollas. The latter are called ray-flowers, the former disk-flowers.

Close examination will show that the corollas of both sorts are borne upon the ovary, and that there is at the point of union a crown of slender roughish hairs which constitute the free border of the adherent calyx. The ray-flowers are without stamens. The disk-flowers have both stamens and pistils. The stamens are attached to the corolla, and form by the union of their anthers a tube through which the style passes. The style is slender and its apex is cleft into two flattish branches which are long and narrow. The

inner surfaces of these branches are stigmatic. Closely packed around the receptacle, like slates on a roof, are greenish leaf-like bracts, forming an involucre which looks somewhat like the calyx of an ordinary flower.

The species that is most likely to be mistaken for the one just described is Heart-leaved Aster. The latter is rather smoother, profusely branched, and has thin, heart-shaped, serrate leaves on slender leaf-stalks. The flowers are a little smaller and rather paler than those of Wavy-leaved Aster.

The *Compositæ* are cross-fertilized by small insects, which carry the pollen from one flower to the expanded stigmas of another. The anthers mature before the style is fully grown, and the dry pollen is pushed or brushed out of the anther-tube by the hairs on the outside of the style as it elongates. When the branches of the style separate, and adherent pollen is carried out of the way, and the stigmatic surfaces thus exposed are ready to receive pollen from contiguous flowers.

After fertilization, the corolla fades; the ovary, to which the withered corolla still clings, ripens into a tiny fruit containing a single seed. The fruit of Aster is crowned by a persistent tuft of slender bristles. Other plants of the order have similar but longer hairs, upon which the seed-like fruits can float in the air; or they possess teeth or grappling-hooks by which they may be attached to the fleece of animals, and thus become disseminated. This calyx-border of hairs or

teeth is named the pappus, and is an important character in distinguishing many of the genera of this large family.

Wavy-leaved Aster is one of about two hundred species of the genus. The species are distributed chiefly throughout North America.

The name Aster, from the Greek ἀστήρ, a star, was of course suggested by the star-like radiation of the strap-shaped flowers on the margin of the receptacle.



PLATE VI.

WILD ORANGE-RED LILY.

Lilium Philadelphicum, L.

THE floral envelopes of all the flowers hitherto figured in this work are readily distinguishable into calyx and corolla. Even in the tiny blossoms which compose the flower-like clusters of Wavy-leaved Aster, the calyx and corolla are very plainly seen to be distinct; the corollas in the flowers of the cluster are either tubular or strap-shaped, while the true border of the calyx consists of delicate hairs. The absence of such clear distinction between calyx and corolla is one of the most characteristic features of the group of plants to which the true lilies belong. The floral envelopes resemble each other so closely that they are most frequently described as constituting one whorl, known as the *perianth*. The divisions of the perianth are termed in descriptive works, *phylla*, *segments*, and by some writers, *sepals*. The parts of the perianth in some instances are united together at the base forming a cup with a variously cleft border, but in numerous genera the segments are entirely separate from each other. This is the case in the Wild Lily. In this plant the separate segments are of very nearly the same size and are arranged

in two closely approximated whorls of three each, the outer answering to sepals of a calyx, the inner to petals of a corolla, together forming a bell-shaped perianth. Each segment is much narrowed at the lower part into a tapering claw which is more or less grooved or furrowed on its inner side, and has its thin edges rolled somewhat outwards. The six stamens stand in front of the perianth segments and slightly adhere to their very base, so that when the segments are removed the stamens generally come with them. Each slender filament of the stamens tapers above into a point which bears a long, linear anther. When the flowers first open, the anthers are somewhat bent over, but soon they swing freely and turn more or less outward from the pistil. The line of dehiscence, or the chink by which the pollen is discharged from the anther, is on the side, but faces, however, a little towards the pistil. The style is long, and thickened at its upper part where it bears a three-lobed stigma. The ovary is three-celled and contains in each of its cells two rows of ovules, very closely packed. The ovary is completely free from the perianth, and as it ripens becomes an oblong pod filled with flattened seeds. The flowers of Wild Orange-red Lily are erect from the first, instead of drooping or nodding as in the Wild Yellow Lily, and the lance-shaped perianth-segments are not curved backwards as they are in that. The groove in the claws of the segments is usually nectariferous.

The stem springs from a scaly bulb, or globular mass of thickened and distorted leaves packed upon a very short axis.

and rises unbranched to the height of two or three feet. Upon the stem the linear or lance-shaped sessile leaves are borne in whorls of three to eight, and at its apex, one, two or three large showy flowers. Sometimes the leaves are in pairs or even alternate, but they are usually whorled. The green leaves of a bulbous plant like this are the factory in which the food is prepared from inorganic matter, for the future needs of the plant; and the store of food is safely packed away in the underground leaves, whence it can be withdrawn as occasion may require, for building up new structures. The supply of stored-up nourishment in lily-bulbs by no means inconsiderable, and in one species, at least, according to Lindley, it has been employed as food for man. The bulb of the lily figured in the plate is about an inch thick and is said by Mr. Elwes in his attractive monograph of the genus *Lilium*,¹ to be edible. A new bulb is formed annually at the side of that of the preceding year. Mr. Elwes states that "the growth of the bulb in this species is peculiar and unlike that of any other lily, though it has some analogy with *L. avenaceum*. It is a curious fact that all the American lilies, though varying remarkably among themselves, differ entirely in their bulb-structure from those of Europe and Asia: and the same peculiarity is noticeable among the American Fritillaries, which, as far as I know them, have bulbs composed of small white scales loosely at-

¹Elwes. Monograph of the genus *Lilium*. Part II.

tached to a solid central axis, from which the stem springs. Of all the Old World lilies and fritillaries only two, namely *Lilium avenaceum* and *Fritillaria Kamschatkensis*, resemble their American congeners in the formation of their bulbs; and both of these are restricted in their geographical limits to the shores of North-eastern Asia, which have many affinities, both botanical and zoölogical, with the Pacific coast of North America."

Mr. Baker in his memoir on Tulipeæ,¹ says that "all the plants of the tribe are able, in a state of nature or under cultivation, to hold their ground and increase more or less by means of bulb-reproduction independent of being multiplied by seed." The tribe includes Lilies, Tulips, Fritillaries and so on, and exhibits four types of underground development, one of them, the scaly perennial bulb in its modifications, being exemplified in true lilies. He makes a further remark respecting the distinctions between the genera of Tulipeæ, which may be here quoted. "The great genera are usually distinguishable at a glance by the coloring of the flowers—the blue-black basal blotches of the Tulips, the tessellation of the Fritillaries, and the minute brownish dots passing into papillæ of the Lilies being in each case quite characteristic, but by no means extending to every species of the genus."

This lily is common in fields where the soil is sandy and

¹J. G. Baker. On Tulipeæ. Journal of the Linneæan Society, 1873.

at the edge of open woods in Eastern North America, its range extending even to the Rocky Mountains. It is very easily cultivated, and bears exposure to the sun very well; in this respect it is superior to some of the other wild species. Mr. Elwes states that "it is more indifferent to drought than most of the other species, and will thrive in a hot sunny place; whereas if planted in peat soil with *Canadense*, *superbum*, etc., it dwindles and dies."

Plants of this species were sent by Bartram to Miller in England about the middle of the last century. The account of the plant given by Miller is worth transcribing:—"Lily with very short Leaves growing in Whorls round the stalks, bell-shaped Petals, whose Bases are very narrow, and erect Flowers. The root of this flower was sent me by Mr. John Bartram from Philadelphia who found the plant growing naturally in that Country It flowers in July, but produces no seeds in this Country."¹ Mr. Elwes, on the other hand, says that he has "obtained good seed from it by keeping the pots rather dry in a warm greenhouse. The seed germinates readily and grows more quickly than usual; and as I am rather doubtful whether the bulbs can be increased freely by means of offsets, I think this will be the best means of propagating the plant."

Respecting other North American lilies it may be said

¹ Figures of the most beautiful, useful and uncommon Plants described in the Gardener's Dictionary. By Phillip Miller, F. R. S. London, 1760. Page 110.

that of the twelve species, four are found east of the Rocky Mountains, and the other eight west of the Sierra Nevada, only two of them extending north of California. The Rocky Mountain specimens of *L. Philadelphicum* are referred to the variety *andinum*, which has rather more numerous, and perhaps larger flowers.

The name *Lilium* is by Wittstein¹ "derived from the Celtic *li* (white), referring to the best known species."

¹ Etymologisch-botanisches Handwörterbuch. Erlangen, 1856, page 525.



Drawn by Isaac Sprague

Armstrong & Co. Lith.

Plate V.

LARGER BLUE FLAG.

PLATE V.

LARGER BLUE FLAG.

Iris versicolor, L.

THIS is the more common Flower-de-luce of our northern meadows and swamps. A stout, irregularly-branched, and very uneven underground root-stock gives rise to the flowering stems and to the flat, compact cluster of leaves. The flowering stems are leafy, and vary greatly in height: in rich grounds they are frequently three feet high, but in drier and poorer soil they are dwarfed to less than a single foot. The leaves are nearly vertical, and are of the shape of slender sabre-blades: this shape disguises their true structure. Ordinary leaves, like those of the Aster and Gerardia, illustrated in this work, have an upper and an under surface unlike in their character. In the Blue Flag, on the contrary, the blade is erect and its surfaces, which stand right and left, are alike. A careful examination shows that what appears to be a flat leaf-blade is in fact a leaf-blade folded lengthwise. Towards the tip the folding is complete and the lateral halves are blended, but nearer the base they are still more or less distinct, and a crevice is there left in which are clasped the flower stem and the base of the sword-like leaf above it on the opposite side. That which answers to the under side of

other leaves is here the outside. The clusters of leaves at the ground are arranged in what is termed an equitant manner; each leaf, by its folding, sits astride the leaf just above it. The lower leaves are from one to two feet long; those upon the flowering stems are much shorter. The stems are sometimes branched, and then bear more than one cluster of flowers, the stalk of each flower-cluster having at its base one of the smaller leaves just referred to. The flowers may be single or in clusters of two, rarely more, surrounded by clasping bracts or floral leaves of unequal size. The bracts are two inches long, or somewhat less, and at the edges are brownish in color, and often dry and papery. Each flower is borne upon a stalk which is a trifle longer than the bracts. What seems to be an enlarged portion of the stalk just below the flower is in reality the ovary surrounded by the adherent base of the floral envelopes. This is cylindrical, or nearly so, and a little less than one inch long. It is surmounted by a short, funnel-shaped tube about half as long as the ovary, and from the margin of the tube spring the showy parts of the blossom. The floral envelopes, in this case known as the perianth, consist of an outer row of three segments which are recurved and much larger than the three erect divisions in the circle next within. The outer segments are narrow at base, and widen into an obovate blade which is turned downwards and backwards. These have been called by one of the older writers, and very recently re-named by Mr. Baker, the "falls," while the erect but much smaller

segments within have received the name of "standards." The falls have a wavy edge, and are conspicuously marked on the upper surface by a network of deep purple lines, and in the middle near the base by a narrow orange spot. The standards are less brilliant in color, and less striking in their markings. The delicate texture of the drooping segments and the gracefulness with which they sway in even the lightest breeze suggested the common name, Blue Flag, by which the plant is known.

Mr. Longfellow has beautifully described in his "Flower-de-Luce" this waving of the falls, and the more usual surroundings of the plant.

"Born in the purple, born to joy and pleasance,
Thou dost not toil nor spin,
But makest glad and radiant with thy presence
The meadow and the lin.

"The wind blows and uplifts thy drooping banner,
And round thee throng and run
The rushes, the green yeomen of thy manor,
The outlaws of the sun."

The parts of the flower as drawn in the plate are of the ordinary size, and it is not necessary therefore to give any measurements of either the falls or the standards. Alternating with the three standards come three slender over-arching plates which are of a purple color and might be easily mistaken for petals. These are branches of the style,

which crowns the ovary and which is more or less united with the perianth-tube. The curved style-branches have at their tip a small deltoid crest which turns slightly backward. Under this there is a thin shelf, the upper surface of which is covered with minute hairs and is moistened with a sticky secretion. This shelf is the true stigma, and was first detected in another *Iris* by Sprengel near the close of the last century. The stigmatic lip is very small. Curved under the three branches of the style are as many stamens, each of the three having an anther as long as the filament which bears it. The anther is not only below the stigmatic shelf, but it is turned outwards, and at maturity opens on the outside only, thus discharging the pollen not upon the stigma but away from it.

A bee, or other insect, attracted to this flower, generally alights upon the most convenient landing-place, the upper surface of one of the falls, and searches for the nectar, to which the brilliant veining and the orange line serve as a guide. To the back of the insect some of the pollen from the anther is pretty sure to adhere, but as the insect withdraws from that place, none of the pollen reaches the sticky shelf of the stigma, for the insect's body comes in contact only with its smooth lower surface. If the insect visits another Blue Flag flower in search of more nectar, it will first touch in passing, on its way to the landing-place, the projecting lip of the overarching style, and this, as has just been said, is stigmatic. Thus the pollen is there deposited.

Sprengel describes this very fully in the now famous work on the fertilization of plants by insects, but by no one has this story of *Iris* been so well told as by Professor Gray in "How Plants Behave."

The ripe fruit of Larger Blue Flag is an oblong, three-sided capsule, much rounded at the angles. A second and more slender species of Blue Flag which frequently grows with the one above described, has a capsule distinctly prismatic and with sharper angles, and the capsule is acute at both ends.

The slender Blue Flag is the species described in Dr. Gray's Manual under the name *Iris Virginica*, L., but to which the name *Iris prismatica*, Pursh., has lately been re-assigned by Mr. Baker.

The seeds of *Iris* are almost round, much flattened, and closely packed in rows.

The order *Iridaceæ*, to which *Iris* belongs, is represented by many genera in Southern Africa and in the subtropics of both hemispheres. *Gladiolus*, *Sparaxis*, *Watsonia*, *Tritonia*, *Crocus*, and *Iris*, are among the better known of the genera cultivated for ornament. The genus *Iris* comprises about eighty species, mostly if not exclusively found in the north temperate zone. A few of the more showy species in cultivation are: *Iris Germanica*, *Iris sambucina*, *Iris Florentina*, whose root-stock yields "orris-root," and *Iris Persica*.

The underground stems of many species are acrid and have been employed in medicine.



Drawn by Isaac Sprague

Armstrong & Co. Lith.

Plate IX.

ARROW LEAVED VIOLET

VIOLA SAGITTATA AITON.

EARLY SEDGE.

CAREX PENNSYLVANICA. LAM

PLATE IX.

ARROW-LEAVED VIOLET.

Viola sagittata, Aiton.

OUR violets may be conveniently arranged in two classes: the first comprising the species with leafy stems, the second the species in which the stem is subterranean and the leaves and flower-stalks appear to spring directly from the ground. The Arrow-leaved Violet belongs to the second group. The leaves are clustered around the end of a thickened underground stem which might easily be mistaken for a stout root. This stem, or root-stock as it is called by botanists, is roughened more or less by short and jagged teeth, and is unevenly covered by scales or rudimentary leaves, or by decaying bases of the leaves of previous years. It often happens that the root-stock branches irregularly, and the divisions are closely crowded together into a compact mass, from the surface of which slender roots start out in every direction. The leaves rise from the root-stock on short and rather wide petioles. In early spring most of the leaf-stalks have somewhat narrow margins; the later are longer and have merely a shallow channel, but no margins like the early ones. The leaf-blade is rather more than twice as long as broad, and at the base

is very obtuse. Many of the leaves are distinctly arrow-shaped, and some have the barbs turned outwards so that they are better described as halberd-shaped. Both of these forms are often more or less disguised, owing to the tendency of the sides of the leaves to roll in at the base. The margin of the leaf is finely-toothed except at the base, where it is more coarsely and irregularly cut. The surface is slightly hairy. When it grows in dry ground it is often very hairy, and the leaves are ovate: this form has been described as a distinct species, *Viola ovata*. A species of violet known as *Viola cucullata*, Aiton, and regarded as distinct from the one figured in our plate, is liable to be mistaken for it. The leaves are generally broader, the base is heart-shaped rather than arrow-shaped, and the sides of the leaf are much more strongly involute than in Arrow-leaved Violet. Both species are very variable, and there are some connecting forms which cannot be referred with certainty to either.

The flowers are borne singly on slender stalks which have, about half-way up, two delicate bracts. The calyx of the violet is made up of five distinct sepals of nearly equal size, each one having an appendage at the base. The five purplish-blue petals are slightly veined; the lower somewhat larger than the others and prolonged backwards to form a short, blunt spur. This spur serves as a reservoir for nectar. The lateral petals, and occasionally all, are conspicuously bearded. The stamens are short and are slightly united together at the base, and sometimes by the edges, forming a

tube around the style. The anthers face towards the pistil and at maturity open lengthwise. The filaments of the two lower stamens are slightly spurred at base. These spurred filaments secrete nectar. The pistil is composed of three carpels, uniting at base to form a one-celled ovary, in which the ovules are arranged in lines down the walls. The style is thickened above, or club-shaped, and the stigma which is above the upper edge of the anthers has a beak on its lower side.

It is perplexing to see in what way the dry pollen of violets can reach the stigmatic surface. At maturity it is held in the tubular case of the anthers, as if in a funnel, but the mouth of the funnel is closed by the style, so that unless this is forcibly displaced, the pollen cannot fall out. The description of *Viola odorata*, given by Sprengel at the close of the last century, is so interesting that a translation of a portion is herewith given.

“Now I will tell how I discovered the way in which this flower is fertilized. . . . It had long seemed to me that the secret of the whole thing must be hidden in the shape of the style which can be so easily raised up, after which it falls down. After many fruitless trials, I happened once to have the good fortune when examining a cut flower, to put it in the position which it naturally has. This solved the riddle. For after I had raised the flower up above the level of my eyes so that I could look into it from beneath, there fell, when I pressed the style upwards with a slender needle, a great deal of pollen, scattered like sand from a sand-box. This phenomenon, which I had not in the least expected, actually made me cry out. It was for

my mind what a flash of lightning in a dark night is for the eye. It revealed to me at once the whole secret."¹

Sprengel, by means of gauze, excluded insects from plants of this species, and no fruit was formed.

Now it so happens that the conspicuous, although not fragrant, flowers of the Arrow-leaved Violet seldom produce seed-vessels. Careful search this spring failed to detect any undoubted case of fertility.

Later in the season, say from the latter part of May throughout the summer, this violet, like a good many others, has minute flowers which are exceedingly fertile, and these give rise to the numerous capsules seen on the plant in July and August. These later flowers can easily be found by a slight examination of the clusters of leaves, among which they are almost hidden; they are very minute and look like tiny buds. They are found to have five sepals which close tightly around the pistil, and one, two, or, in some cases, three rudimentary petals. There are generally two stamens; in a few instances, traces of one or two others have been found, but in most flowers there are only two. The style is shorter than in the showy blossoms, and it is so curved that the stigmatic end of the hook comes directly in contact with the two anthers; the pollen is very scanty. From what is known in reference to closely allied violets we may conjecture that the pollen without leaving the anther-sac may emit

¹ *Das Entdeckte Geheimniss der Natur* — 1793. p. 393.

its tubes and fertilize the ovules.¹ This is plainly a case of close-fertilization.

The fruit having the persistent calyx at its base consists of a capsule with three equal valves. The seeds are attached to the inner surface of the valves. At maturity the valves spring apart, and each, in drying, folds up lengthwise, pressing by its edges firmly against the roundish and smooth seeds. Thus the seeds are held in rows in a sort of vise, from which, when the pressure becomes great enough, they are projected with force. The fruit of Witch-hazel, *Hamamelis Virginica*, projects its seeds in somewhat the same manner.

The order *Violaceæ*, to which our plant belongs, contains more than two hundred species, and the single genus *Viola* more than one hundred. The violets are mostly herbaceous. Some of the tropical ones, however, are shrubs.

The pansy (from *pensée*, thought). *Viola tricolor*, in its innumerable varieties of size and color, and the fragrant violet, *Viola odorata*, have long been prized in cultivation. The American species have scarcely any odor.

The Arrow-leaved Violet was first cultivated in Europe in 1775.

The little plant which Mr. Sprague has placed in the background of his figure of the Arrow-leaved Violet, is *Carex Pennsylvanica*, L., a sedge which blooms in early

¹ Note at end.

spring. The dry, chaff-like flowers are minute and clustered in spikes near the end of the flower-stalks. The upper spike consists of staminate blossoms; the other spikes are pistillate.

NOTE.

Flowers, like the late ones in Arrow-leaved Violet, which do not open, are called *cleistogamous*. In Kuhn's list¹ of plants bearing such flowers, forty-four genera are mentioned; from this list Mr. Darwin² has removed a few names, but has added others. In a cleistogamous flower the ovules are fertilized by the pollen of the same flower, thus furnishing unequivocal cases of *close-fertilization*. Many of the plants have, however, showy blossoms to which insects are attracted, and which may thus afford opportunities for the transfer of pollen from one flower to the stigma of another flower on a plant of the same species; the latter is, as we have previously seen, *cross-fertilization*.

¹ *Botanische Zeitung*, 1867.

² *Forms of Flowers*, 1877.



Drawn by Isaac Sprague

Armstrong & Co. Lith.

Plate VIII.

COLUMNAR CONE-FLOWER.

RUDBECKIA COLUMNARIS, PURSH.

PLATE VIII.

COLUMNAR CONE-FLOWER.

RUDBECKIA COLUMNARIS, D. DON.

The general structure of the order *Compositæ*, to which this plant belongs, was explained at some length in the notes upon Wavy-leaved Aster. It was then shown that many minute flowers are closely aggregated upon a general receptacle, and that the compact, regular clusters often resemble single blossoms. In the special case in hand, the floral leaves, or bracts, are few and very small. They are of about the same number as the five to eight showy, yellow ray flowers, and they frequently alternate with them, thus increasing the resemblance of the two circles to the calyx and the corolla of simple flowers. The ray flowers are broadly ovate, and are in most cases irregularly toothed at the end, drooping somewhat and curving slightly near the edge. Instead of being pistillate and capable of being fertilized, like the ray flowers of the Wavy-leaved Aster, they have neither stamens nor a perfect pistil, and are therefore known as neutral. The tubular disk flowers are crowded upon a columnar receptacle and bloom in succession from below upwards. Each of these flowers is subtended, in fact almost clasped, by a membranaceous, concave bract, slightly

thickened above. These small bracts or scales are collectively termed the "chaff."

The plant is a coarse herb, three or four feet high, with irregular branches, and alternate, pinnately divided leaves. The branches are conspicuously grooved, and rough, like the leaves.

A variety occurs in which the rays are of a rich red-brown color, or have a brown centre, with a more or less wide margin of yellow.

The species here figured has been referred to the genus *Lepachys* (from *λεπίς*, a scale, and *παχύς*, thick); but according to Bentham and Hooker, the species of *Lepachys* must be referred, as has been done in this paper, to *Rudbeckia*. The differences between the two genera are really very slight, and consist chiefly in the characters of the fruit. In *Lepachys* the fruit is flattened laterally and has a narrow margin. *Rudbeckia* has a fruit which is four-angled, without margin, and flat at the summit.

Rudbeckia columnaris grows in the northwestern portions of the United States. The name *Rudbeckia* was assigned by Linnæus in honor of the Professors Rudbeck, his predecessors at the University of Upsal, Sweden.



Drawn by Isaac Sprague

Armstrong & Co. Lith.

LANCE-LEAVED LOOSESTRIFF

PLATE VII.

LANCE-LEAVED LOOSE-STRIFE.

Steironema lanceolatum, Gray.

(*Lysimachia lanceolata*, Walter.)

WITHIN the geographical limits of Dr. Gray's Synoptical Flora of North America, the order *Primulaceæ*, or the Primrose Family, comprises twelve genera, eleven of which are represented by one or more species east of the Mississippi River. One of the eleven, however, has only recently retaken its place as a genus. In Dr. Gray's Manual our plant is referred to the subgenus *Steironema*, a section of *Lysimachia*. In the restored genus *Steironema*, the flowers have a wheel-shaped corolla like that of the American *Lysimachias*, but in the bud-state of the former, each lobe of the corolla is rolled up around the stamen which stands in front of it, while, in the latter, the corolla lobes are not thus involute. The genera may be still further distinguished. In *Steironema* there are sterile stamens, or staminodia, that is, stamens without anthers, but in *Lysimachia* there are none. In the former, the staminodes alternate with the anther-bearing stamens, and



PLATE X.

LONG-LEAVED ASTER.

Aster longifolius, Lamarck.

THE structure and the arrangement of the flowers of the Aster have been described on page 21. Each cluster is made up of minute blossoms of two kinds so disposed upon a common receptacle that the resemblance of the whole to a single large flower is striking and almost deceptive. The flower-like clusters, or heads, in the present case are somewhat larger than those described under the name of Wavy-leaved Aster, and there are other differences to which attention must be called.

The lower leaves in wavy-leaved Aster are ovate, or somewhat heart-shaped and have conspicuous leaf-stalks and undulate margins; the upper leaves are narrower and have shorter leaf-stalks with broad wings, or else clasp the stem by a heart-shaped base. The leaves in the species now under consideration are lanceolate or linear and have no petioles. None of the leaves are heart-shaped. In the former species, the bracts or scales of the involucre surrounding the clusters are closely appressed, and the inner ones are longer than the outer and lower; each is terminated by a minute greenish

tip. In the present species, the bracts are more nearly alike in size and are arranged in rather open order; each scale is greenish, at least at its tip which is much recurved. The curving backwards of the end of the scales gives a rough appearance to the involucre, which is very clearly shown in the figure. In some varieties of Long-leaved Aster, the foliage and the bracts of the involucre are unlike the plant of the plate, and may be mistaken for certain closely-allied species, particularly *Aster Novi-Belgii*, L. The involucre-scales in the latter are more closely packed, the leaves are somewhat broader, and the flowers are a trifle smaller than in the Long-leaved Aster, but the stem and the leaves are equally smooth in both plants. *Aster puniceus*, L., which is generally very rough, has a smooth variety found in shady places, but it has only two or, at most, three bracts to the involucre, whereas our plant has usually more than three. In his Manual of Botany, Dr. Gray says (p. 233) that "the species of this group are still perplexing."

The mode of inflorescence in Compositæ can be easily understood by the description given on p. 23, but it is now necessary to refer to the order of flowering in the clusters and the separate blossoms. There are two general methods of flowering, or inflorescence, which we may term centrifugal and centripetal. In the former, often called definite, the central flower, or flowers, of the cluster are the first to mature; the others follow in succession from within outwards, or from above downwards. In centripetal inflorescence, other

wise termed indefinite, the lower flowers of the cluster are the first to open, those higher in the cluster, or nearer the centre, maturing later. It sometimes happens, however, that the clusters themselves may follow out one method, while the succession of their appearance, flowering and fruiting, may be after the other method. We have such a case in Compositæ, the order to which the Asters belong. The terminal clusters are farthest advanced, and their flowers are often faded before the flowers in the lower clusters have fairly opened, and it may therefore be said that the sequence is always from above downwards, so far as the heads or clusters are concerned. This is what a German writer has called "the blooming of the plant." But if we observe any one cluster apart from the rest, it cannot fail to attract attention that the terminal or central flowers are the very last to open; and hence the order is from below upward, or from the outside towards the centre. This is "the blooming of the cluster." Hence upon a single plant two kinds of inflorescence, the centripetal as regards individual clusters, the centrifugal with respect to the whole plant, are clearly discernible. Such a mode of inflorescence is called "mixed;" it is a case of centripetal clusters maturing after the centrifugal manner. In a well-known plant, *Echinops*, the heads consist of single flowers, each with its own involucre, crowded together upon a receptacle where they constitute a spherical cluster, answering, one may say, to the collective clusters of a whole plant. If the rule respecting

flowering holds good for *Compositæ* in general, its globular mass of one-flowered clusters in *Echinops* should begin to bloom at its summit, and so it does.

The Long-leaved Aster is found abundantly along the banks of streams, and in moist places in the Eastern States.

The following notes by the founder of the species will be found of interest.¹

“This Aster is remarkable on account of its leaves which are three or four inches long, scarcely five or six lines broad, pointed, glossy, of a brownish-green, and with occasional teeth on the margin. The stem is two or three feet high, more or less branched above and carries terminal flowers (clusters) which resemble those of the Easter daisy. Their calyx (the involucre) is loose, has many leaves, and is not imbricated.”

¹ Lamarck in *Encyclopédie méthodique, Botanique*, 1, p. 306.



Drawn by Isaac Sprague

Armstrong & Co. Lith.

MOCCASON FLOWER.

Plate XI.

CYPRIPEDIUM ACAULE, Ait.

PLATE XI.

MOCCASON FLOWER.

Cypripedium acaule, Aiton.

Two broad leaves arise in this case from an underground stem, and appear to spring from the very root. Such leaves are therefore termed *radical*. The apparent absence of any stem in plants like the one now under consideration has rendered necessary in descriptive botany the term *acaul-lescent*. But the stem is really present, although concealed underground and often disguised by assuming the shape of a thickened root. Such underground stems bear traces, often indistinct to be sure, of the nodes, or joints, which mark true stems, and by the possession of these nodes their identity as stems can be recognized.

The two leaves are inrolled or sheathing at the base, and expand broadly above, where they are conspicuously nerved. At the apex they are obtuse, but at the very tip are sometimes short-pointed: the margins are entire and the surface pubescent. Between the leaves there ascends a slender leafless stalk bearing a single flower. Such a peduncle or flower-stalk rising from the ground is termed a scape. Upon the

scape in this case there is a single narrow lanceolate bract, or floral leaf, close to the flower.

The structure of the flower can best be understood by comparing it with the regular and simple flower of the lily, described on page 25. The three outer leaves of the perianth of the lily answer to the two outer greenish segments in the Moccason flower, but in the latter plant, one of the segments is plainly made up of two united. The three inner perianth leaves alternate with the three outer, and this becomes very plain when we separate the larger outer segment into the two of which it is made up, for it is upon the very middle or dividing line of this that the deformed larger inner perianth-segment or petal rests. The two lateral petals are spreading, but are not so wide as the outer segments which, as in the case of the lily, may be termed the sepals. The lateral petals are greenish, tinged with purple. The large petal, the *labellum* or lip, is an obovoid, pendulous sac, more or less inflated and almost two inches long, always longer than the united sepals on which it rests. In front there is a shallow indentation, or closed fissure, running the whole length. At its point of union with the other petals there is an irregular body bent nearly at right angles and standing over the upper end of the cleft. This is known as the column and consists of the blended stamens and pistil of the flower. The ovary is below the plane of the perianth-segments, curved and obscurely grooved, and one-celled, bearing many minute ovules on three placentæ or lines, down the walls. The column surmounts the

ovary and is seen upon close inspection to be made up of two good anthers and a sterile one, borne upon and united with the bent style. The fertile stamens have very short filaments, which support two-celled anthers having pollen which is granular and powdery, except where it is exposed by the breaking down of the wall of the anther. Here it is adhesive and clings to any surface which it touches, but if it is detached it carries also with it the pollen which lies next to it, and often the whole can be thus removed. The stigma is broad, somewhat three-lobed, the middle lobe being much larger than the marginal ones which are convergent below. Of its surface, mention will be made farther on. Above the column is the sterile stamen, and this is rhomboid, thick, sharply pointed and turned down. Thus of the six stamens in the lily, only three are here apparent, and only two of these bear pollen. Moreover, instead of having an ovary free from the perianth as the lily has, Moccason flower has an inferior ovary: the stamens are not distinct as in the lily, but are confluent with the pistil. It may be further noticed that the sterile stamen in plants of this genus corresponds in position to the single fertile stamen in other plants of the order *Orchidaceæ*.

Respecting the mode of fertilization, it must be first said that the pollen cannot of itself come in contact with the stigma; it must be brought there. The mode in which this is secured by insect agency has been described by Mr. Darwin in his work on the Fertilization of Orchids, by Professor

Delpino, and by Dr. Gray. The latter gave a very interesting account, in 1862,¹ from which the following extract is taken.

"In all the species it is impossible that fertilization should be effected without extraneous aid. That aid may perhaps be given in the manner that Mr. Darwin supposes, that is, by a large insect inserting its proboscis into either of the lateral entrances at the base of the labellum, under the anther, and so thrusting some of the pollen forwards to the stigma, or more likely carrying some away to another flower and leaving it on its stigma while attempting to gather the slight glutinous exudation that moistens the beard of long hairs which line the labellum beneath. But an attentive consideration of the arrangement, in the species above mentioned, convinces us that the work is done by insects such as flies which crawl bodily into the flower. They may enter by one lateral opening, and so take a load of pollen upon the back of the head as they pass under the anther, which they would rub against the stigma, since they must crawl directly under it to feed on the nectar of the beard close underneath; and escaping by the opening under the other anther, they would carry off some of its pollen to the flower of the next plant visited. But although we have not been able to detect insects actually at work, we confidently gather from their traces and from a variety of facts which we cannot here enumerate, that they ordinarily go in by the front entrance (even in *C. acaule*), crawl under the ample face of the stigma, as they feed, where they cannot well avoid rubbing their heads or backs against the stigma, and, passing on, make their exit by one of the lateral openings which now become visible to them, almost inevitably carrying off pollen which they would convey to the stigma of the next flower. Now the stigma offers no slight confirma-

¹ Am. Journal of Science and Arts, 1862.

tion of this hypothesis, in a structure which has never before been noticed, but which is very striking in *C. spectabile*, etc., and most admirably adapted to the end in view. That is, the broad stigma, instead of being smeared with glutinous matter as in ordinary orchids, is closely beset with minute, rigid, sharp-pointed papillæ all directed forwards, so that the surface when magnified is like that of a wool-card of the olden time; and any pollen, which an insect working its way upwards to the base of the labellum carries upon its head or back (to which alone it could be expected to adhere), would be neatly carded off by and left on the stigma."

In a work published in 1873,¹ Dr. Gray uses nearly the same words in describing the process, and then adds:

"This mode of action we first predicted from an inspection of the flower and a simple experiment. It has been confirmed by repeated observations. The early-flowering and purple Stemless Lady's-slipper differs from the others in having its larger slipper or sac pendent, and with a long slit in front, instead of a round open orifice. The two lips of the slit are mostly in contact, but the fly may readily push its way in: the way of exit is more open than in the other species."

The flower last referred to is the one figured in the plate.

In the second edition (1877) of *Fertilization of Orchids*, page 230, Mr. Darwin accepts Dr. Gray's explanation, and says:

"I first introduced some flies into the labellum of *C. pubescens*, through the large upper opening, but they were either too large or too

¹ *How Plants Behave*, p. 32.

stupid and did not crawl out properly. I then caught and placed within the labellum a very small bee, namely, *Andrena parvula*, which seemed to be of about the right size, and this by a strange chance proved, as we shall presently see, to belong to the genus on which, in a state of nature, the fertilization of *C. Calceolus* depends. The bee vainly endeavored to crawl out again the same way by which it had entered, but always fell backwards, owing to the margins being inflected. The labellum thus acts like one of those conical traps with the edges turned inwards, which are sold to catch beetles and cockroaches in the London kitchens. It could not creep out through the slit between the folded edges of the basal part of the labellum, as the elongated, triangular, rudimentary stamen here closes the passage. Ultimately, it forced its way through one of the small orifices close to one of the anthers, and was found when caught to be smeared with the glutinous pollen. I then put the same bee back into the labellum; and again it crawled out through one of the small orifices, always covered with pollen. I repeated the operation five times, always with the same result. I afterwards cut away the labellum, so as to examine the stigma, and found its whole surface covered with pollen. It should be noticed that an insect in making its escape must first brush past the stigma, and afterwards one of the anthers, so that it cannot leave pollen on the stigma, until being already smeared with pollen from one flower it enters another; and thus there will be a good chance of cross fertilization between two distinct plants."

Purple Moccason flower is not rare in Eastern and Northern woods. It flowers in May and early June.

The generic name *Cypripedium* is derived from *κύπρις*, Venus, and *πόδιον*, a buskin, that is, Venus's slipper.

The plant is commonly known as Lady's slipper, but the

name placed at the head of these notes is considered more appropriate, for the shape of the labellum is not unlike that of an Indian Moccason. Another popular name may be mentioned, recorded in Dr. Torrey's Flora of the State of New York, namely, Noah's ark. The resemblance to the latter is not obvious.



Drawn by Isaac Sprague

WILD CLEMATIS.

Armstrong & Co. Lith.

Plate XII.

CLEMATIS VIRGINIANA. I.

PLATE XII.

WILD CLEMATIS.

Clematis Virginiana, L.

THE slender, slightly woody stems bear opposite compound leaves. The pairs of leaves are remote from each other. Each leaf has three leaflets which are ovate, obtuse or even heart-shaped at base, and acute at apex. Their margins are coarsely and irregularly cut, and their surface is strongly veined. The main leaf-stalk, or that which is common to the leaflets, is more or less dilated at the point where it joins the stem, and is often grooved or channelled. The partial petioles, or the leaf-stalks of the separate leaflets, are shorter and more slender. Near the end of the young, growing stem these compound leaves may be seen in many stages of development, and their behavior while expanding presents many points of interest. To begin with, it will be observed that the tip of the young shoot upon which the undeveloped leaves are borne is not stationary, but is moving slowly in a circle, or ellipse, with some degree of regularity. Only the upper joints of stem, or internodes, are thus capable of spontaneous movement; the lower ones are rigid and at a stand-still. The interesting description by

Mr. Darwin, of the movements observed in two other species of *Clematis*, may serve to attract attention to similar phenomena in the plant now under observation. Of *Clematis glandulosa*, he says:

“The thin upper internodes revolve, moving against the course of the sun, precisely like those of a true twiner, at an average rate, judging from three revolutions, of three hours forty-eight minutes. The leading shoot immediately twined around a shaft placed near it; but, after making an open spire of only one turn and a half, it ascended for a short space straight, and then reversed its course and wound two turns in an opposite direction. This was rendered possible by the straight piece between the opposed spires having become rigid. . . . If the footstalk of a young leaf be rubbed with a thin twig a few times on any side, it will in the course of a few hours bend to that side; afterwards becoming straight again. The underside seemed to be the most sensitive: but the sensitiveness or irritability is slight compared to that which we shall meet with in some of the following species. . . . The young leaves spontaneously and gradually change their position: when first developed the petioles are upturned and parallel to the stem; they then slowly bend downwards, remaining for a short time at right angles to the stem, and then become so much arched downwards that the blade of the leaf points to the ground with its tip curled inwards, so that the whole petiole and leaf together form a hook. They are thus enabled to catch hold of any twig with which they may be brought in contact by the revolving movement of the internodes.”

Of *Clematis calycina*, the following account is given:

“The young shoots are thin and flexible: one revolved, describing a broad oval, in five hours thirty minutes, and another in six hours,

twelve minutes. They followed the course of the sun, but the course, if observed long enough, would probably be found to vary in the species, as well as in all the others of the genus. It is a rather better twiner than the last two species (*C. montana* and *C. Sieboldi*). The stem sometimes made two spiral turns round a thin stick, if free from twigs; it then ran straight up for a space, and reversing its course took one or two turns in an opposite direction. This reversal of the spire occurred in all the foregoing species. The leaves are so small compared with those of most of the other species, that the petioles at first seem ill-adapted for clasping. Nevertheless, the main service of the revolving movement is to bring them into contact with surrounding objects, which are slowly but securely seized. The young petioles, which alone are sensitive, have their ends bowed a little downwards, so as to be in a slight degree hooked; ultimately, the whole leaf, if it catch nothing, becomes level. I gently rubbed with a thin twig the lower surfaces of two young petioles; and in two hours thirty minutes they were slightly curved downwards: in five hours after being rubbed, the end of one was bent completely back, parallel to the basal portion; in four hours subsequent it became nearly straight again. To show how sensitive the young petioles are, I may mention that I just touched the undersides of two with a little water-color, which, when dry, formed an excessively thin and minute crust; but this sufficed in twenty-four hours to cause both to bend downwards. While the plant is young, each leaf consists of three divided leaflets which barely have distinct petioles, and these are not sensitive; but when the plant is well grown, the petioles of the two lateral and terminal leaflets are of considerable length and become sensitive, so as to be capable of clasping an object in any direction.

When a petiole has clasped a twig, it undergoes some remarkable changes, which may be observed with the other species, but in a less strongly marked manner, and will here be described once for all. The

clasped petiole in the course of two or three days swells greatly, and ultimately becomes nearly twice as thick as the opposite one which has clasped nothing. When thin transverse slices of the two are placed under the microscope their difference is conspicuous: the side of the petiole, which has been in contact with the support, is formed of a layer of colorless cells with their longer axes directed from the centre, and these are very much larger than the corresponding cells on the opposite or unchanged petiole; the central cells, also, are in some degree enlarged, and the whole is much indurated. The exterior surface generally becomes bright red. But a far greater change takes place in the nature of the tissues than that which is visible; the petiole of the unclasped leaf is flexible and can be snapped easily, whereas the clasped one acquires an extraordinary degree of toughness and rigidity, so that considerable force is required to pull it into pieces. With this change, great durability is probably acquired; at least this is the case with the clasped petioles of *C. vitalba*. The meaning of these changes is obvious, namely, that the petioles may firmly and durably support the stem." ¹

The flower clusters spring from the axils of the compound leaves and vary much in size and attractiveness. The flowers of the species are polygamo-diœcious, that is, perfect and imperfect flowers occur on the same plant, and the imperfect flowers on a given plant are all of one sort: they are all staminate or all pistillate. In some instances the perfect flowers are numerous, but generally they are very few compared with the imperfect ones. The staminate or male flow-

¹The Movements and Habits of Climbing Plants. Page 46. By Charles Darwin, M. A., F. R. S.

ers are more conspicuous when in full bloom than are the pistillate, or female: but the latter are very showy when their fruits are ripe. The pistils ripen into achenia, or dry one-seeded fruits which do not open. Each achenium retains its long style, and this becomes feathery as it ripens, so that a single flower has a cluster of coarse divergent recurving threads, each one at maturity silvery and plumose. The lustre is as brilliant as that of silk. There is but little difference between the male and female flowers as regards the shape or size of the sepals, the only floral envelopes. In both, the four sepals are thin, obovate and curved slightly inward at their edges. They are somewhat longer than the stamens and carpels.

The stamens and carpels are many, and distinct from each other and from the sepals: the ovules are anatropous, that is, they are inverted upon, and united with, the tiny funiculus or supporting thread, and these ripen into anatropous seeds which contain a minute embryo at the base of fleshy albumen. The characters above mentioned are those of the natural order *Ranunculaceæ*, to which Wild Columbine belongs. A comparison of Wild Clematis with Wild Columbine will show very plainly that there are few, if any, points of similarity between them in stem or leaf or mode of flowering. Even in the structure of the flowers themselves there are wide differences, and it is only when we examine the essential organs, their development and their relations to each other and surrounding parts, that we observe a close likeness.

If now these points of likeness are borne in mind in the study of many of our other common wild and cultivated plants, like Marsh Marigold, Buttercups, Larkspur, Monks-hood, and so on, so diverse in habit and properties, strong reasons will appear for placing them in the natural Order above referred to.

Wild Clematis is common in thickets east of the Mississippi, climbing in the manner before described, and forming tangles which are decorated with fragrant flowers in July and August, and ripening the fruits in September or a little later.

Clematis is derived according to Wittstein from κλήμα a tendril.



Drawn by Isaac Sprague

MOUNTAIN FRINGE

Armstrong & Co. Lith.

Plate XIII.

ADLUMIA CIRRHOSA, Raf.

PLATE XIII.

MOUNTAIN FRINGE.

Adlumia cirrhosa, Raf.

THE common names, Mountain Fringe, and Climbing Fumitory, which have been given to this plant, are descriptive of the delicacy of the sprays of its foliage and the clusters of its flowers. "Fumitory" is from the Latin *fumus*, smoke, and is a name given to the whole family of plants, of which that figured in the plate is one of the most attractive. The natural order *Fumariaceæ* has been reduced in Bentham & Hooker's Genera Plantarum to the rank of a suborder of *Papaveraceæ*, the Poppy Family. In the true Poppies the petals are of nearly the same size, flat and open; the stamens are indefinite in number and distinct. In the Fumitories, the inner petals are unlike the outer ones, and the stamens are few. Climbing fumitory, or mountain fringe, is very closely allied to *Dicentra* from which it differs chiefly in the corolla. The four petals of the corolla in both genera are in two sets, the outer ones larger and spurred at the base, the inner much narrower, and at top somewhat spoon-shaped where they enclose the stigma. In the former genus they are firmly united together, are spongy at base, and at maturity of the fruit remain as a dry and

withered envelope. The petals in *Dicentra* are distinct from each other. It may be further noted that the seeds in mountain fringe are crestless, while in *Dicentra* they have a conspicuous crest near their point of attachment. The sepals in both these genera are two, small and papery, and are very early deciduous. The stamens are also nearly the same in both; being in two sets of three each. In *Dicentra*, the filaments of each set are often distinct or only slightly united, but in *Adlumia* they are united nearly to the top.

The middle anther in each set is the largest. It should be further noticed that one group of stamens is opposite each of the largest or outer petals: this is understood to be a case of *chorisis*, an increase in the number of parts in a floral whorl by the division of what is morphologically only one organ into two or more: in this instance each stamen-leaf has been congenitally divided at summit into three stamens, and this group stands in the place of a single member.

The pistil, of two carpels, has a slender one-celled ovary with the placentæ, or lines to which the ovules are attached, upon the walls, or, as it is technically termed, parietal. The stigma is flattened, two-lobed or two-crested, and is held together with the anthers within the flat hood-shaped summits of the inner petals. When an insect visits the pendent flowers for the purpose of obtaining the nectar which is secreted at two places inside the spurs, it pushes back the hood, exposing the anthers which at once yield their pollen, but the stigmatic

surface is above the anthers and usually receives no pollen at all from its own flower. Dr. Hildebrand,¹ who has investigated the fertilization of the principal species of the order *Fumariaceæ*, regards this a case which is adapted to close fertilization within the bud, but that upon the visit of an insect cross-fertilization is unavoidable.

The ovary of *Adlumia* ripens into a capsule which is silique-like, or like a mustard pod. It contains when ripe half a dozen or a dozen seeds, which are smooth and black.

The plant is a biennial herb, that is, it is without woody tissue, and runs through its course from seed to flowering in two years, then dying. The stems are slender and branching, and are supported by the delicate petioles of the younger leaves which are almost as slender as any tendrils can be. Of this climbing, Mr. Darwin says,²

"I raised some plants late in the summer; they formed very fine leaves, but threw up no central stem. The first formed leaves were not sensitive; some of the later ones were so, but only towards their extremities, which were thus enabled to clasp sticks. This could be of no service to the plant as their leaves rose from the ground, but it showed what the further character of the plant would have been, had it grown tall enough to climb. The tip of one of these basal leaves, whilst young, described, in one hour thirty-six minutes, a narrow ellipse, open at one end and exactly three inches in length: a second ellipse was broader, more irregular, and shorter, viz.:—only two and a half

¹ Jahrbücher für Wissenschaftliche Botanik, vii, p. 437.

² The Movements and Habits of Climbing Plants, p. 76.

inches in length and was completed in two hours two minutes. From the analogy of *Fumaria* and *Corydalis*, I have no doubt that the internodes of *Adlumia* have the power of revolving."

The leaves are alternate, the older ones are pinnately twice or thrice compound, the leaflets are extremely delicate, three-to-five-lobed. The general petiole is short, but the divisions are much longer and are very slender. The whitish or rosy-purple flowers are clustered in panicles which spring from the axils of the leaves.

Adlumia cirrhosa is the only species of the genus, and is indigenous to the Northern United States, chiefly at the West where it thrives in damp woods or copses. It is a decorative plant of so elegant a habit and so easy of cultivation that it should be more widely employed.

The generic name was given by the naturalist Rafinesque in 1808, in honor of Mayor Adlum, who is said by Dr. Torrey to have been a distinguished cultivator of the vine. The account given by Rafinesque in 1836 is as follows:

"*Adlumia* Raf. 1808, Dec. Beck. Noticed as a genus as early as 1804, in the garden of the Collector Adlum, and also in the Alleghanies, at Peters' mountain, only indicated in 1808, since well established by DeCandolle and beginning to be adopted. Very distinct from *Corydalis* by Corolla bigibbose by two spurs as in *Dielytra*, but four petals spungy and coalescent, persistent over the pod.

A. cirrhosa, R. D. B., *Fumaria fungosa*, Aiton, *F. recta*, Mich., *Corydalis* of many botanists. Scandent cirrhose, leaves decom-
pound,

racemes laxiflore axillary. In the Alleghanies from Mattawan Mountains to Apalachian Mountains. Perennial.

Var. *rupestris*, trailing on rocks, leaves cæspitose.

Var. *elator*, trailing up trees ten feet high, leaves remote.

Var. *alba* and *rosea*, with white or rose flowers instead of usual pale incarnate. All seen alive."

A very interesting account of Rafinesque and his botanical writings was published by Dr. Gray, in 1841.¹ Concerning him, Dr. Gray says:

The "task, although necessary as it appears to us, is not altogether pleasing; for while we would do full justice to an author who, in his early days, was in some respects greatly in advance of other writers on the botany of this country, and whose labors have been disregarded or undervalued on account of his peculiarities, we are obliged, at the same time, to protest against all of his later and one of his earlier botanical works."

Further on Dr. Gray makes use of the following language:

"Then follows a list of the genera which he proposes to establish upon new species. This we introduce entire, on account of the evidence it affords of Mr. Rafinesque's sagacity at that early period."

The first plant mentioned in the list is "*Adlumia (cirrhosa)*, which is the *Fumaria fungosa*, Ait."

¹ Am. Journ. Science and Arts, 1841. Vol. XL. No. 2.



Drawn by Isaac Sprague

Armstrong & Co. Lith.

CALOPOGON.

Plate XIV.

'CALOPOGON PULCHELLUS. R. Brown

PLATE XIV.

CALOPOGON.

Calopogon pulchellus, Robert Brown.

THE Natural Order, Orchidaceæ, to which Moccason Flower (described on page 43) and Calopogon belong affords very instructive illustrations of what is known as Morphology. This department of Natural History is based upon a comparison of the different shapes which the parts of organisms may assume, and the recognition of the fact that these organs so diverse in form and office are only modifications of a few members, common throughout. For instance, it is held that any higher plant, like those depicted in these plates, consists only of an axis upon which lateral outgrowths are symmetrically arranged. These lateral appendages are leaves, and have definite positions, modes of arrangement, and order of appearance; but they do not always develop into green leaves. In fact, they may assume almost any shape and take on almost any kind of work, such as that of climbing, as in *Clematis* and *Mountain Fringe*, or they may form constituent parts of blossoms. Hence we may say that a flower is made up wholly of axis and leaves, but many of the leaves are very much disguised. If now we compare the flowers of two closely allied plants, for instance, the two Orchids, Moccason flower and Calopogon, and

keep in mind the fact that they are composed of the same materials, but that the corresponding parts differ in shape and perhaps in function, we shall find that much light is cast upon the structure of both. In the Moccason flower, two of the three outer perianth segments are firmly united to form one, while in *Calopogon* they are distinct. The lip, or labellum, in the former, is a large inflated sac; in the latter it is a slender arching body, somewhat widened at its summit, and tapering below into a three-ribbed or three-nerved claw. Near the point where the dilated summit begins to grow narrower below, the lip is densely bearded on its upper side with hairs of different colors, whence its generic name *Calopogon*, from *καλός*, beautiful, and *πόγων* bearded. Its attachment is so slight at the point of insertion that the whole labellum can be moved easily up or down, as if upon a hinge. A further point of difference between the floral envelopes, in the two flowers which are now under comparison, is their apparent position as respects the scape on which they are borne. The labellum in *Calopogon* appears to be upside down, while that of the Moccason flower is properly pendent; but the fact is, it is only by a twist in the ovary, and sometimes in its short supporting pedicel, that the latter has assumed this position. *Calopogon* has no such twist. The column in *Calopogon* is slender, curves downwards and is free from the labellum. Near its apex it bears two lateral wings and, at its apex, a single anther which is two-lobed, and contains four pollen masses.

When the little lid which covers the pollen is removed, and the pollen is displaced, it is seen to be pulverulent and held together lightly by cobwebby threads. Now it may be remembered that in Moccason flower there were two fertile anthers, one on each side of the column, and a sterile stamen above. In *Calopogon*, the lateral stamens are missing; but, on the other hand, the one corresponding to the sterile stamen in the other flower is here that which bears pollen. In front of the anther is the stigmatic surface. If, next, the modes of fertilization in the two flowers be contrasted, functional differences will appear which will be very striking. As we have seen, the labellum in Moccason flower is a trap; in *Calopogon* it is merely an arched roof decorated with attractive colors. The pollen can no more reach the stigma in one case than in the other, unless outside aid is afforded; and how the transfer is effected by insects visiting the flower of *Calopogon* may be at once seen. Further mention will be made of this when another flower of the same family is compared with it.¹

The scape bears several of these showy purplish or rose colored flowers, each one of which is subtended by a minute bract. The scape springs from a solid, roundish stem, or corm, and is enveloped near its base by a single bright green, grass-like leaf, and by the vestiges of older leaves below.

Calopogon pulchellus grows in peat bogs and is usually associated with one or more other species of orchids.

¹ *Arethusa bulbosa*, L.



PLATE XV.

GOLDEN SENECIO.

Senecio aureus, L.

THIS Composite has a perennial root, from which arises a slender stem one foot to three feet high. At the base there is a cluster of simple, rounded radical leaves which have long petioles, and scalloped margins. A little above the point from which the radical- or root-leaves start, there spring other leaves spatulate or more often lyrate in form, and having shorter leaf-stalks. The leaves higher still upon the stem are alternate, lance-shaped, variously cut and toothed, and are without any petioles at all. The flower-heads are arranged in a branching cyme which usually has one part in which many flower-stalks come from one point. This character is well shown in the plate. The heads are of medium size, many-flowered, having from eight to fifteen ray-flowers which are all pistillate. The scales of the involucre are arranged in a single series, but may have a few very small scales at the base. Other minute scales are scattered here and there upon the stalks bearing the heads. The receptacle is nearly flat and has no chaff, or bracts, upon its surface. The free border of the calyx (pappus) is composed of many very delicate hairs.

The genus *Senecio* is perhaps the largest genus of flowering plants, having nine hundred species. The immense genus *Carex* comprises, according to Dr. Francis Boott, between five hundred and six hundred species. Bentham and Hooker credit to the genus *Astragalus* about six hundred species, but the author of a recent memoir makes the number not far from one thousand. The genus *Senecio* contains many plants which are highly prized in cultivation, but which have received other names than *Senecio* by which they are known. Among them must be mentioned the species of *Cacalia* or Tassel-flower, the many beautiful Cinerarias, the so-called German Ivy, and *Farfugium*, cultivated for its variegated leaves. The common plant used so effectively for contrasts, "Dusty Miller," is a species of *Senecio*, but is usually called *Cineraria maritima* by florists. The significance of the name *Cineraria*, from *cinis*, ash, is obvious. Some plants of this genus have been called "Groundsel." This word is said to be a corruption of the Anglo-Saxon "*grundswelge*, from *grund*, ground, and *Swelgan*, swallow. *Senecio vulgaris* is still called in Scotland and on the Eastern Border (of England) *grundy-swallow*."¹

Senecio is derived from *senex*, an old man, "alluding to the hoary hairs which cover many species, or to the white hairs of the pappus."² In Wittstein's Etymological Botanical Dictionary it is said to be so called because the flower-heads

¹ Prior's Popular Names of British Plants, p. 99.

² Gray, Manual of Botany of Northern U. S., p. 279.

of most species are bald (rayless), or because the receptacle becomes bald after the fruit falls.

The species of *Senecio* are found throughout the temperate regions of the globe, but not extending into the tropics.

The species here figured is common in swamps, and is extremely variable, particularly as regards the leaves.



Drawn by Isaac Sprague

SESSILE LEAVED BELLWORT.

Armstrong & Co. Lith.

PLATE XVI.

SESSILE-LEAVED BELLWORT.

Oakesia sessilifolia, S. Watson.

(*Uvularia sessilifolia*, L.)

IN his revision of the North American Liliaceæ,¹ Mr. Sereno Watson has divided the old genus *Uvularia* into two genera; one of these retains the old Linnæan name, to the other he has assigned the name *Oakesia*. The species figured in the plate is one of the two North American species of this new genus. The more obvious characters that distinguish the two genera may be contrasted as follows. The root-stocks in *Oakesia* are long and slender; those in *Uvularia* are short. In the former, the stem above ground is acutely angled and bears sessile, clasping, rough-margined leaves; in the latter, it is cylindrical and has smooth perfoliate leaves, that is, sessile leaves with the edges of the recess at the base united around the stem. Dr. Gray says, in the new edition of his Text-book,² that in such cases "it is the stem which is literally perfoliate, *i. e.*, which seemingly passes through

¹ Proceedings of the Amer. Acad. of Arts and Sciences, vol. XIV, p. 221, etc.

² Text-book, page 107.

the leaf; but it is customary, though etymologically absurd, to call this a perfoliate leaf. *Uvularia perfoliata* (the very plant now under consideration) in the later growth of the season reveals the explanation of the perfoliation: the base of the lower leaves conspicuously surrounds and encloses the stem: that of the upper is merely cordate and clasping; the uppermost simply sessile by a rounded base!" The inflorescence is terminal in both cases as in all the genera of the tribe *Uvulariæ*, but while the solitary flowers of *Uvularia* evidently terminate the stem or its leafy branches, those of *Oakesia* are on short pedicels opposite the leaves. The latter are as truly of the definite sort of inflorescence as the former, but they would be thought at first to be indefinite. Attention to the fact that, although they are lateral, they spring not from the axils of leaves but are opposite them, will make it clear that the blossom is indeed a terminal one which has been thrust aside by the further and stronger growth of the bud between it and the leaf. Such cases of disguised terminal inflorescence are elsewhere met with. Other marks of distinction are noted by Mr. Watson, for instance, the character of the segments, or divisions, of the perianth. In *Oakesia* they are described as "obtuse or acutish, carinately gibbous and without callosities." In *Uvularia* the segments are acuminate and are obtusely gibbous without the keel or ridge previously spoken of, but they have "a callus or ridge each side of the deep nectary." The remaining more essential characters are given, as those above have been, nearly in

Mr. Watson's own words except when it seems advisable to paraphrase or simplify the technical language.

Uvularia. Capsule coriaceous (that is, of leathery texture), depressed obovate, obtusely 3-lobed, and splitting at its summit down the midribs of the carpels, or leaves, of which the pistil is composed.



Uvularia
grandiflora.

Seeds 1 or 2 in each cell, nearly spherical, brown, half covered by a thin white aril (or appendage, growing from near the point where the seed is attached to the ovary).

Oakesia. Capsule membranous, elliptical, acutish at each end, or short-stalked below, three-angled and acutely winged, opening late and slowly.



Oakesia
sessilifolia.

Seeds 1 to 3 in each cell, nearly spherical, brown, with a very much swollen spongy brown ridge on the outside.

Mr. Watson says: "The division of *Uvularia*, which seemed to be required, affords an opportunity to honor the memory of Mr. William Oakes, whose persistent zeal in investigating the flora of the fields and mountains of his native New England, makes appropriate the union of his name with one of the plants which he himself knew so well."

Sessile-leaved Bellwort grows in rich woods from Canada to Florida, and westward to Arkansas.



PLATE XVII.

ARETHUSA.

Arethusa bulbosa, L.

THIS plant is closely allied to *Calopogon* described on page 73, and may be conveniently described by contrasting the two species.

Both spring from corms, or solid bulbs, but the scape or flower-bearing stalk of *Arethusa* when it begins to flower, has no long linear leaf like that of *Calopogon*; it has, instead, two or three little bracts, or sheaths, tinged with purple, often green, which tightly envelop the stem. The scape of the former bears only one rose-pink flower; the latter has two, three, or more, which are purplish or rose-purple. The sepals or three outer segments of the perianth, and two of the inner segments in both cases, resemble one another closely, but the third segment is unlike the others. In *Calopogon* the ovary and the stalk below it do not twist, and hence this third segment, the lip or labellum, is on the inner side, and next the axis. But in *Arethusa* the lip is on the outer or anterior side, being brought to this position by a plain turn or twist of the ovary or its support. In the former the lip is remote from the column, in the latter it is adherent. The relations can be best understood by a comparison of two of the three

diagrams given below. The first is a ground-plan of *Calopogon*, the second of *Arethusa*.

The third diagram is the ground-plan of a Lily and exhibits certain numerical relations which are concealed to some extent in figures one and two.

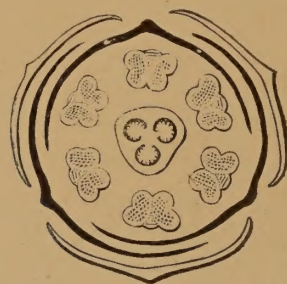


Calopogon.

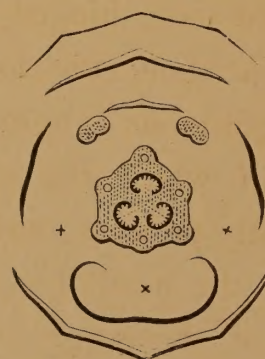


Arethusa.

It will be noticed that only one of the six stamens in the lily is represented by an obvious stamen in either of the other diagrams. The other stamens which are assumed



Lilium.



Cypripedium.

to exist in the type are suppressed and in the diagrams they are indicated by the crosses.

If now we compare with these three flowers, a fourth, *Cypripedium* or Moccason flower, page 53, we see that two

of the stamens of the type are plainly present, while a third exists in a deformed and much disguised condition.

The recognition of such disguised parts is the task of morphology. Some bearings of this subject will be treated of, after further illustrations suitable for the purpose have been presented in this series.

The cross-fertilization of this flower can be well understood from the drawing given below, and by recurring to the statements made relative to *Calopogon*. In Dr. Gray's Text Book of Botany¹ the following account of *Arethusa* gives, in clear language, the views held in regard to this matter. The pollen "of *Arethusa* is in four loose and soft pellets in an inverted casque-shaped case, hinged at the back, resting on a shelf, the lower face of which is glutinous stigma, over the front edge of which the casque-shaped anther slightly projects; and this anther is raised by the head of a bee when escaping out of the gorge of the flower. The loose pellets of pollen are caught upon the bee's head, to the rough surface of which they are liable to adhere lightly and so to be carried to the flower of another individual, there left upon its glutinous stigma by the



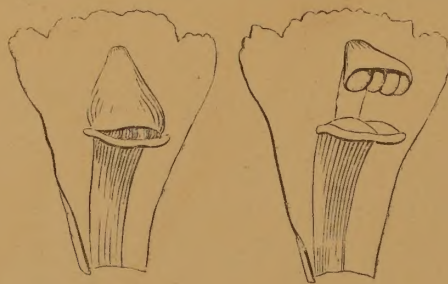
Arethusa Section

¹ Edition of 1880, p. 230.

same upward movement which immediately afterward raises the anther-lid and carries away its pollen, to be transferred to a third blossom, and so on."

The segments of the perianth possess a beautiful texture which has well been called crystallium. They have a fine rose-purple color, almost the same as that of *Rhododendron Rhodora*. The flowers emit a pleasant fragrance.

Arethusa was the name of one of Diana's nymphs who was changed by Diana into a spring. The name was applied by Linnæus to this plant on account of its occurrence in springy places. The plant is rather rare, and is found growing in bogs with its corm imbedded in the sphagnum or peat moss, sometimes two or three inches below the surface. It is often associated with *Calopogon* and *Pogonia ophioglossoides*.



Arethusa. Anthers and Stigma.



Drawn by Isaac Sprague

Plate XVIII

PALE LAUREL.

KALMIA GLAUCA.

Armstrong & Co. Lith.

XVIII.

PALE LAUREL.

Kalmia glauca, Ait.

THIS is a delicate shrub which grows in the cold peat bogs of the Northern States. Its further range is wide. In the appendix to Sir John Richardson's "Arctic Searching Expedition" it is said that "it inhabits moorish places from the Northern States to the Arctic Sea, and crosses the continent to Sitka."

The stems are straggling, and the irregular branches, especially the smaller ones, are plainly two-edged, having a ridge which extends from the base of each leaf to the next. Such branches are technically known as *ancipitous*. The evergreen and leathery leaves are opposite, and almost sessile. They are about an inch in length, and in shape they are oblong, or lanceolate. The margins are entire and rolled slightly backwards; the surfaces are smooth, the upper one is shiny, the lower is pale with a bloom and is known as *glaucous*. A similar whitening bloom is seen on many leaves; for instance, those of the common cabbage.

The plant blooms in spring, Its purple, or lilac blossoms are borne in few-flowered terminal corymbs, and have at the

base of their smooth stalks rather firm bracts. The flowers are a little larger than those of narrow-leaved laurel or "lambkill"; but they have nearly the same shape, and they possess the following characters in common. The corolla is very broadly bell-shaped, or saucer-shaped and has five lobes. On the inner surface there are ten pouches, or deep depressions; which correspond of course to the ten elevations on the outer or lower surface. In the bud, an anther is lodged in each of these pockets and when the flower opens the anther is there held, pretty firmly, causing a bending back of the slender and elastic filament. When the anther is released from its confinement, the filament flies up like a spring, coming towards the centre of the flower. Of course when the flower has been open for some time, the elasticity of the filament held by its detent is lost, and the anther may become spontaneously displaced, but usually the fresh flowers are visited by insects by which the filaments are touched, thus releasing the anther. At their apex the anthers have minute chinks through which the powdery pollen easily falls and through which it is forcibly projected when the fresh filaments are touched and the anthers disengaged. When a bee visits a flower of *Kalmia*, it hovers over it, often coming in contact with the stigma, and in its endeavors to reach the nectar at the bottom of the shallow cup of the corolla, forcibly removes the anthers from their pockets, and receives upon the under side of the body the discharge of pollen suddenly thrown out. Some of this pollen comes in contact with the stigma of that flower,

but some of it is doubtless carried to the next flower of *Kalmia* visited. In the second flower the ten springs are in turn liberated and the pollen is shot out of the anther as before. The statement is made by Professor Beal, of the Agricultural College of Michigan, that "when a cluster of blossoms is covered with fine gauze no stamen gets liberated of itself while fit for action, and no seed sets."¹

The ovary of *Kalmia* is five-celled and many-ovuled, ripening into a globose pod which contains many seeds. At maturity the erect fruit breaks open through the septa or partitions which form the flat walls of the cells.

The genus contains about five species. Those which are commonest in the United States are *Kalmia latifolia*, spoon-wood or Calico-bush, and *Kalmia angustifolia*, common Lamb-kill. The name is commemorative of Kalm a pupil of Linnæus. He journeyed extensively in America about the middle of the last century.

¹ Gray's How Plants Behave, p. 54.



Drawn by Isaac Sprague

Armstrong & Co. Lith.

FRINGED GENTIAN.

Plate XIX

GENTIANA. CRINITA. FROEL.

PLATE XIX

FRINGED GENTIAN.

Gentiana crinita, Frœl.

THE specific name *crinita* refers to the deeply fringed upper border of the four blue-purple corolla-lobes. These are obovate or somewhat wedge-shaped, and are united below sometimes only slightly at the base. By their overlapping edges they constitute a broad tubular or bell-shaped corolla, from the mouth of which four flattish expansions (the *limb* or *border*) spread nearly at right angles.

The calyx is likewise four-parted, and each segment has a conspicuous rib which extends to the very base. The four stamens alternate with the lobes of the corolla and are inserted upon it: between their filaments, at their base, is a row of glands. The pistil consists of two carpels which are united to form a one-celled ovary bearing ovules "over the whole inner surface*," although they are often more abundant at the two vertical lines which are the obscure parietal placentæ. The ovary ripens into a spindle-shaped capsule containing many small roughish seeds. The fruit is borne upon a minute but conspicuous stalk or *stipe*. The flowers are terminal, and are

* As first pointed out by the late Prof. H. J. Clark, Gray, Man., ed. 2. 1856, p. 345.

frequently so grouped as to present the appearance of a leafy cyme. The leaves are opposite, ovate-lanceolate, and have a clasping base which is slightly cordate. These and the slender stem are generally smooth throughout. All parts of the plant, especially the roots, possess a bitter principle. In the species *Gentiana lutea* the root is officinal.

The order *Gentianaceæ* contains 49 genera many of which, like the plant here figured, are remarkable for their beauty. The genera *Gentiana* and *Sabbatia* are perhaps the most attractive. The genus *Gentiana* comprises 180 species found throughout the cooler parts of the temperate zone; represented in North America by about forty species, including a few well characterized varieties. Its name is said to have been derived from that of a King of Illyria, Gentius.



Drawn by Isaac Sprague

Armstrong & Co. Lith.

PRAIRIE TURNIP.
(POMME BLANCHE)

PSORALEA ESCULENTA, PURSH.

Plate XX

PLATE XX.

POMME BLANCHE.

Psoralea esculenta, Pursh.

THE Order Leguminosæ comprises widely distinct genera, and has been conveniently divided into three suborders. These suborders are alike in having a simple pistil which, in fruit, becomes some sort of a Legume, though in a few cases even this character is more or less disguised. In the *Mimosa* suborder the flowers are regular, and the petals or lobes of the corolla meet at the edges without overlapping (valvate æstivation). The suborder *Cæsalpinieæ* has nearly regular flowers, but the petals are imbricated in the bud, one of the petals having both edges wholly covered by contiguous ones. In the suborder *Papilionaceæ*¹ the corolla is generally irregular and of a characteristic shape suggesting remotely a butterfly on the wing. Hence the name of the suborder, but the group of genera comprised under it contains many plants to which the name is wholly inapplicable. For instance, in one genus belonging to the *Psoralieæ* section, the corolla is reduced to a single petal.

The genus *Psoralea* now to be considered has a well-marked papilionaceous corolla, bluish-white or purplish-blue

¹ From Lat. *Papilio*, a butterfly.

in color. The upper petal is more or less expanded and is known as the standard (or *vexillum*); the two lateral ones are the wings (*alæ*); the two in front and below are in contact and, taken together, constitute the *carina* or keel.

The stamens are united into two groups, occasionally into only one. The anthers are not in all cases perfectly formed. The simple pistil ripens into a thickish pod sometimes roughened by wrinkles, and deviates in a remarkable manner from the true legume. The legume is a pod formed by the maturity of a simple pistil and when fully ripe opens by both sutures, that is, by two lines one of which answers to the united edges of the pistil-leaf, and the other to its midrib. But in this genus, and in a few other genera of the order, the legume does not open readily, if at all, at maturity. It is therefore nearly or quite *indehiscent*.

This anomalous legume is one-seeded and has a minute curved tip. The flowers are clustered in crowded spikes which are rather to be called heads, since they are inclined to be globular instead of elongated. They are borne on long peduncles and appear in June.

The leaves are alternate, palmately compound with five leaflets, or rarely only three. The leaflets are lance-oblong or in one variety obovate, somewhat hairy, and like the calyx more or less dotted with minute glandular points. From the occurrence of these glands the name of the genus was derived.¹

¹ From *ψωραλῆος*, scurfy.

The stem is about a foot high¹, herbaceous and perennial. It springs from a thickened root which is spindle-shaped or turnip-shaped and more or less stored with starch. On account of this root, which is esculent, the specific name was given, and for the same reason the common names were bestowed by the *voyageurs*,—*Pomme blanche*, and *Pomme de Prairie*.

Mr. Sprague has communicated the following note respecting the plant. "In the autumn the top of the plant dies and separates from the root, near the ground, and is blown about the prairies. After the top has gone the root cannot be readily found, and hence the Indians dig them in August for their winter use. The root lies deep in the ground, and is about the size of a hen's egg. The outside is covered with a thick integument almost as tough as wood and of a dark brown color. The inside is whitish and not unlike a chestnut in appearance and taste, but not so sweet. The Indian women dig the roots with great facility by means of a pointed stick two or three feet long."

Concerning the use of the plant by the Indians, the following references are of considerable interest.—

"It approaches very near to *P. pentaphylla*, Willd., sp. pl. 3, p. 1352, which is fully described and figured by B. Jussieu in Act. Par. 1744, p. 381, t. 17. But not only the botanical differences but the medical use made of the Mexican plant proves their distinctness. The present plant produces the famous bread-root of the American western Indians on which they partly subsist in winter. They collect them in large quantities and

¹ In a well-marked variety the stem is very much shorter than this.

if for present use, they roast them in the ashes where they give a food similar to yams; if intended for winter use, they are carefully dried, and preserved in a dry place in their huts. When wanted for use they are mashed between stones, mixed with some water, and baked in cakes over the coals. It is a wholesome and nourishing food, and according to Mr. Lewis's observation agreeable to most constitutions; which he observed was not the case with the rest of the roots collected by those Indians for food. This root has been frequently found by travellers in the canoes of the Indians, but the plant which produces it has not been known until lately." Pursh, 476.

The following note is from Nuttall, Genera, II, 102.

"The root is similar in form to that of *P. canescens*. Taste rather insipid, but not disagreeable either raw or boiled; the latter is its common mode of preparation among the savages. Its texture is laminated, always tenacious, solid, and never farinaceous." The species of *Psoralea* are for the most part found in the western states and territories, and in South Africa. The species figured in our plate ranges from the western states southward to Louisiana and Texas.



Drawn by Isaac Sprague

Armstrong & Co. L.

SWEET WHITE VIOLET.

Plate XXI

VIOLA BLANDA, WILLD.

PLATE XXI.

SWEET WHITE VIOLET.

Viola blanda, Willd.

THREE white violets are frequently found growing together : *Viola lanceolata* having lanceolate leaves attenuate at base, *Viola blanda*, the one figured in the plate, with roundish heart-shaped leaves, and *Viola primulæfolia* which, with its ovate leaves abrupt at base, serves to connect the other two. All three are acaulescent, that is, there is no apparent stem ; the leaves and flower-stalks spring from a subterranean stem, or rhizoma, which creeps or spreads irregularly beneath the surface. During the early summer the rhizoma, or root-stock, of these violets gives rise to thread-like branches under ground or barely at the surface of the soil.

The flowers in these three white species agree in nearly every particular. They are small, and they have a short spur at the base of the lower petal, into which are thrust two appendages borne upon the back of the filaments. The lower petals are purple-veined in all of them.

The lateral petals of *V. primulæfolia* are slightly bearded with delicate hairs ; the corresponding petals of the other two species are seldom bearded at all. *V. lanceolata* is usually described as beardless.

Besides the white spring blossoms referred to, there are produced also inconspicuous flowers later in the season. Similar flowers are found also in the arrow-leaved violet (p. 37) and are termed cleistogamic. They are more fertile than the ordinary blossoms, although they are incomplete and do not open. This cleistogamic state of *Viola blanda* * was long ago described as a distinct species, *Viola clandestina*, Pursh.

Pursh adds to his description of the species *clandestina* the following note: "This singular species differs from all the rest in producing its flowers as it were under ground, as they are always covered with rotten wood or leaves; they are of a chocolate brown, very small; the seed vessel buries itself still deeper in the ground and is large in proportion to the plant. The inhabitants know it by the name of *Heal-all*, being used by them in curing all kinds of wounds and sores." It is to be added that in his description Pursh says that the flower has linear petals scarcely longer than the calyx.

The conspicuous flowers of *Viola blanda* are slightly fragrant, but the faint odor is unlike that of the European fragrant violets.

The species abounds in wet meadows throughout the northern States.

* "*Viola clandestina*, Pursh, of which we have seen specimens in Lambert's herbarium, is only the apetalous state of this species, which, like most other violets with subterranean stems, puts forth late in the season stolons which bear one or more apetalous flowers." Torrey and Gray Flora, p. 139.



Drawn by Isaac Sprague

WHITE ALDER.

Armstrong & Co. Lith.

Plate XXII

CLETHRA ALNIFOLIA, L.

PLATE XXII.

WHITE ALDER.

Clethra alnifolia, L.

Ericaceæ, the Heath Family, to which this plant is referred, comprises several subfamilies which are, in the main, easily distinguished from each other. It is however somewhat doubtful whether *Clethra* should be placed in any of the subfamilies, or appended to the order as an anomalous genus.

In Bentham and Hooker's *Genera Plantarum* fifty-one genera of the order *Ericaceæ* are arranged in groups, or tribes; the fifty-second genus, *Clethra*, is added as an anomalous one. By Dr. Gray in his *Synoptical Flora of North America*, it is referred to the group *Pyrolineæ*. In the *Proceedings of the Am. Academy* 12, 61, Dr. Gray says, "*Clethra* agrees with the *Pyroleæ* in having primarily extrorse anthers, as well as in the simple pollen and completely polypetalous corolla. These characters are fully equal in value to those upon which De Candolle and others break up the original *Ericaceæ* into separate orders, and, if apprehended by Bentham and Hooker, might have led them to give ordinal rank to the *Pyroleæ*, appending *Clethra*, which they almost exclude from *Ericaceæ*. Much preferring to retain the order as a great whole, I could combine *Clethra* and the tribe *Pyroleæ* into the third suborder *Pyrolineæ*."

The genus contains about twenty-five species scattered through America, Madeira, Japan and the Malay Archipelago. Two species only are found within the limits of the United States, *Clethra alnifolia* and *Clethra acuminata*, the latter occurring chiefly in the Alleghanies. The former extends farther southward, but it is found also much farther northward, even in Maine, nearly always in wet thickets near the coast. *Clethra alnifolia* is a small much-branched shrub with alternate oblong or obovate leaves which are somewhat wedge-shaped. The leaves have conspicuous straight veins and short petioles. They are generally green both on the upper and under surface, but vary in smoothness. In a southern variety the leaves are very hairy on the under surface, and the variety has, on this account, been regarded by some as a distinct species, and variously called *C. tomentosa*, *C. incana* and *C. pubescens*. The leaves are entire at base and serrate either sharply or irregularly towards the apex.

The fragrant white flowers are in erect racemes, which are frequently more or less clustered. The flower stalks are generally covered with a delicate pubescence, or hoariness; this is very noticeable in some clusters. The bracts are awl-shaped, shorter than the flowers, and in this species are not unfrequently persistent even after the fruit has fully formed. Upon a specimen growing in the Botanic Garden at Cambridge the bracts persist upon the dry flower-stalks even through the winter. The corolla consists of five obovate or oblong petals completely

distinct from each other; the stamens are ten with somewhat diverging lobes which open at their base by a chink. In the bud the ¹ anthers are erect and extrorse but after expansion of the flower they are inverted and introrse. "The really basal pores become apical, and the point or apex basal."

The pollen is not composed of four grains united as in most of the genera of the order, but is simple. The pistil is composed of three carpels ² and forms in fruit a three-celled capsule to which the withered style still adheres. The capsule at maturity breaks open through the cells (loculicidal dehiscence) and the separated parts become disconnected from the slender central column, or axis. Subsequently the separated parts, or valves, break into halves. The seeds are small.

¹ Gray's Synoptical Flora, Vol. II, part I, p. 17, 45.

² "Il n'y a rien de particulier à noter quant au développement du périanthe et de l'androcée chez les *Clethra*. Mais il n'en est plus de même du gynécée; car c'est ici le seul genre d'Ericinées cultivées chez nous où les lobes stigmatiques soient placés au-dessus des loges ovariennes." Baillon in *Adansonia*, 1, 201.



PLATE XXIII.

GAURA LINDHEIMERI. Engl. & Gray.

THIS Texan species surpasses in its attractiveness the others of the genus, but even it, by no means, merits the name *Gaura* (from the Greek *γαῦρος*, superb) given by Linnæus. The white or rose-tinted flowers are rather pretty, but only a few in each cluster are in bloom at once. The lower part of the slender raceme bears the ripening fruits and the faded flowers, then come a few showy blossoms, and of course nearer the tip, are the unopened buds. In fading, the petals often become distinctly rose-red.

The hairy, reddish calyx is adherent to the ovary and is prolonged into a slender tube considerably beyond it. The petals are about an inch in length and at the base are narrowed to form a long claw: this is inserted upon the mouth of the calyx-tube. The blade of the petal is turned somewhat to the upper-side of the flower, so that it gives the blossom the appearance of being irregular in shape. In the bud, the petals are convolute, that is, each has one edge covered by another petal, while its other edge in turn covers the petal next in order: thus they appear somewhat rolled together.

The eight stamens are inserted on the throat of the calyx-tube and are turned forward and downward. In front of the base of each filament there is a minute scale-like projection.

The long style bears a four-lobed stigma around which there is a raised border.

The ovary ripens into a four-ribbed, nearly indehiscent nut-like fruit which is generally one-celled and has from one to four naked seeds.

The leaves are alternate, sessile, lanceolate and somewhat toothed. The stem is two or three feet high, generally branched in an irregular manner, and more or less hairy. "The species is found on prairies from Houston (Texas) to the Brazos, flowering from April to May, and through the summer."

The genus contains twenty species occurring for the most part in the warmer parts of North America, and all of them undesirable for cultivation except the one here figured. The order Onagraceæ, or the Evening Primrose family, comprises twenty-two genera, distributed through temperate regions and rare in the Tropics. The plants of this order in common cultivation are *Fuchsia*, *Zauschneria*, *Eucharidium*, *Clarkia*, and several species of *Oenothera*. The showy fireweed or willow-herb, *Epilobium*, which springs up in ground which has been swept by fire is perhaps as widely known as any native plant of the order.



PLATE XXIV.

GALAX-LEAVED SHORTIA.

Shortia galacifolia, Gray.

In January, 1842, Dr. Gray published, in the American Journal of Science and Arts, the characters of a new genus founded upon a single specimen in the Herbarium of Michaux. The specimen was collected by the elder Michaux, not far from a hundred years ago, in the high mountains of Carolina, but was not described by L. C. Richard the author of *Flora Boreali-Americana*, based upon the collections of Michaux. The specimen examined by Dr. Gray in 1839 is that "of a Pyrolaceous-looking plant, out of flower, or rather with corolla and stamens fallen, a dehiscent capsule enclosed in a persistent imbricated calyx and surmounted by a persistent style!"¹ The genus founded upon this imperfect specimen was dedicated by Dr. Gray "to Professor Short of Kentucky, whose attainments and eminent services in North American Botany are well known and appreciated both at home and abroad."² For more than a quarter of a century after the founding of the genus, living specimens were sought in vain. In 1868, Dr. Gray "identified

1. Gray in Am. Journ., 1878, Dec.

2. Gray in Am. Journ., 1872, Jan. 49.

the genus with the *Schizocodon uniflorus* (a Japanese plant) which, singularly enough, was known only by specimens in the same condition, that is with calyx and gynœcium, but neither corolla nor stamens.”¹ In 1870 he further pointed out the relationship between these genera and *Diapensia*, and reconstructed the order *Diapensiaceæ* referring to a separate tribe *Galax* and *Shortia* and “adopted the idea of a probable identity of *Schizocodon* with the latter.” Thus a second species had been added to the hitherto doubtful genus, but the reinforcement came from Japan, a country where Dr. Gray says experience had led him “to expect that any or every peculiar Atlantic States type might recur.” In May, 1877, *Shortia galacifolia* was re-discovered. It was collected in McDowell County, North Carolina, by George M. Hyams, but did not reach Dr. Gray for examination until 1878. In 1879 the locality was visited by Dr. Gray and other botanists, one of whom thus describes it:² “Being now in McDowell County, the *Shortia* locality was visited under the guidance of Mr. George M. Hyams, the actual discoverer. In the secluded and well-protected station, well overshadowed by Rhododendrons and Magnolias was seen the little colony of the plant so long sought and by many so long doubted. Its companions were *Mitchella repens*, *Asarum Virginicum* and *Galax Aphylla*. The space over which the plant extended was perhaps ten feet by thirty, and in all there may have been

1. Gray in Am. Journ., 1878, Dec.

2. Bulletin of the Torrey Botanical Club, 334, July and Aug., 1879.

from fifty to one hundred plants. As the plant multiplies by stolons it is remarkable that its area should be thus restricted. And since in the struggle for life, of two allied plants the weaker 'must go,' Dr. Gray has suggested the probability that its stronger cousin the *Galax* had crowded out the *Shortia*. And here, indeed, in what may be the last foothold of the rarity, *Galax* appeared to be actually doing so. Yet the plants, though comparatively few, were vigorous and healthy. In June even the fruit of this vernal plant had mainly gone by ; but Dr. Gray secured a capsule or two with some seeds."

The leaves are about two inches in diameter, roundish, somewhat cordate, wavy-serrate, with the teeth sharp-pointed. The leaves spring from creeping rootstocks and are long-petioled. Localities of this plant may be hopefully looked for, according to Dr. Gray, on the steep sides of creeks where the Blue Ridge mountains abut against the Black.



PLATE XXV.

PURPLE CONE-FLOWER.

ECHINACEA ANGUSTIFOLIA, D. C.

The genera *Lepachys* (plate viii.) and *Echinacea* are both merged by Bentham and Hooker, in their "Genera Plantarum," into a single genus, *Rudbeckia*. *Rudbeckia*, as generally recognized, has neutral ray-flowers and prismatic (four-sided) marginless achenia: *Lepachys*, described on p. 43, has also neutral ray-flowers but fewer, and flattish margined achenia; *Echinacea* has very long pistillate rays and short four-sided achenia. It should be said, however, that the ray-flowers in the latter genus, although pistillate, are sterile. The involucre has spreading lanceolate scales, which are somewhat imbricated in three or four series: in the species here figured the imbrication is very marked. The conical receptacle bears short disk-flowers, each of which is almost concealed by the bractlet behind. The bractlets or chaff have sharp, stiff tips, whence the name *Echinacea*, from *ἑχίνοϛ* the Sea-Urchin, or the Hedgehog.

In most particulars of structure save those referred to

above, namely the length and kind of rays and the shape of achenia, the description of *Lepachys* will suffice.

The genus *Rudbeckia*, including *Echinacea*, contains about twenty-five North American species, most of which are found in the Middle and Eastern States, but a few occur in Mexico and California.



PLATE XXVI.

CALLIRHOE.

CALLIRHOË INVOLUCRATA, NUTT.

The natural order *Malvaceæ* is very well represented by this plant. The chief distinguishing characters of the order are found in the numerous stamens united by their filaments (monadelphous), and bearing one-celled kidney-shaped anthers. The petals appear to be slightly united together at their base, forming a gamopetalous corolla; but in fact they are distinct; the apparent coalescence arising from their attachment to the bottom of the tube of stamens. Duchartre* has traced out from its origin this union of the claws of the petals with the base of the column of stamens. In his "Memoir upon the Organogeny of *Malvaceæ*," he says, that a little after the calyx has begun to show itself, the central mass of the flower, which up to that time has formed an almost hemispherical and homogeneous elevation, appears to become depressed at its upper part, so that it approaches the form of the frus-

* Annales des Sciences Naturelles. Third Series. IV., p. 126.

tum of a cone. The edge of this frustum gives rise to five protuberances which are alternate with the lobes of the calyx, and therefore might be regarded as the first indications of the petals; but in a short time after these five elevations have become distinct, each one of them divides into two. Thus, instead of five primary elevations, there are five pairs of small papillæ which form a pentagon and afterwards develop into the staminal column. The petals arise a little later at the base of the central common mass and below the level of the staminal papillæ: they are perfectly distinct from each other, in fact, there is even a considerable space between them. As these organs develop they become more or less blended at the circles of origin, and are separate again above. The staminal column differs in different genera. In many, its apex divides into numerous simple filaments, not clearly distinguishable into groups. In others, they are clustered, albeit in some very obscurely; in one, at least, they are plainly separated into two concentric cylinders, the outer of which divides into five narrow branches, all of which are resolved at their apex into short filaments bearing anthers. It may be further mentioned that the inner cylinder also bears anthers. The production of the staminal column and its subsequent divisions belong to what Duchartre terms the *period of multiplication*, in distinction from the *primitive period* in which the pentagonal form is assumed. The period of multiplication presents clearly the phenomena of *deduplication* or *chorisis*.

These terms denote the separation of a leaf into more than one; for instance, the division of a single stamen-leaf into two or more. The chorisis in the stamens of *Malvaceæ* is generally of two kinds: the divisions are either in the line of the radius of the flower, or at right angles to it. In the former case the new leaves stand in front of one another, in the latter they are side by side.

Callirrhoe has a simple short column, bearing very numerous stamens at different heights.

In *Malvaceæ* the anthers are one-celled by early obliteration of the partition by which they would have the usual number of compartments or cells. The pollen escapes through a longitudinal line of dehiscence which runs around the convex side. The pollen-grains in this order are spherical or nearly so, and this outer coat is covered with minute projections.

The carpels are more or less coalescent into a circle around a central receptacle. In one tribe of the order, they are displaced during the development, so that they are aggregated without apparent order into a head. The styles are generally as many as the ovaries, and are united at their base or higher up. They are stigmatic generally from the summit down the inner face; in many the stigmas are capitate. At maturity the carpels separate from each other and from the central receptacle above referred to.

Callirrhoe is distinguished from *Malva* by certain characters of the carpels and seed. The genus was founded by Nut-

tall, but was afterwards renamed in his honor by W. P. C. Barton. After other vicissitudes, the genus, at the hands of Dr. Gray, received again its original name. This name is given in Bentham and Hooker's *Genera Plantarum* as *Callirhoe*; in Gray's *Genera* it has the orthography adopted at the heading of this description. The genus contains seven species wholly North American, growing between the Alleghany and Rocky Mountains. "Nearly all of them are found in Texas and the plains of the Arkansas and Platte; one species (*C. triangulata*) extending northeast to Illinois and Wisconsin; another (*C. papaver*), southeast to Florida." *

The thickened roots of all the species are farinaceous, and it is said that those of *C. macrorhiza* are used as food by the Indians.

The species here figured is worthy of cultivation on account of the showy corolla.

The derivation of the generic name is thus given by Dr. Gray in his *Genera*:

"*Καλλιρόη*, the daughter of the river Achelous, &c. Perhaps Mr. Nuttall drew the name from *καλλος*, beautiful, and *ροία* or *ροά*, whence *Rhœas*, the *Corn-Poppy*, which *C. papaver* so much resembles as to suggest the specific name to Cavanilles, who informs us that the French colonists of Louisiana called the plant by the same appellation, namely, *Coquelicot*."

* Gray's *Genera*, Vol. II., p. 52.



Drawn by Isaac Sprague

Plate XXVII.

SYMPLOCARPUS FOETIDUS, SALISBURY.

Armstrong &

PLATE XXVII.

Symplocarpus foetidus, Salisbury.

In this plant and many others of the same Order (Araceæ), the receptacle, upon which the crowded flowers are clustered, is surrounded by a showy floral leaf, or bract, termed a spathe. In the cultivated Calla (*Richardia Æthiopica*) the spathe is a silvery white scroll of delicate texture, while in the plant of our plate it is thick, fleshy, and of a livid brownish purple color, or green flecked and striped with purple. A few plants of the Order have no spathe, and in some others it is much reduced in size and remote from the inflorescence. Throughout the Order, the spadix, or receptacle bearing the flowers, forms a characteristic feature, although it varies widely in both size and shape. The spadix in the plant now under consideration is a short and globoid axis, on which sessile flowers are thickly packed; or, rather, in which their ovaries are embedded. The flowers are so much compressed by mutual crowding that they assume the form of inverted and truncated pyramids. The perianth consists of four segments, usually described as sepals, which are hollowed somewhat on their inner face and are nearly flat at their thickened summit. A stamen stands opposite each hooded sepal and occupies its cavity until the flower opens; at this period the anthers are liberated and appear on the outside. The style is

slender, straight and four-sided, and tapers to a point, on which is the minute stigma. The stigma is ready for fertilization before the anthers of the flower furnish pollen for it. The plant is, therefore, proterogynous. The two-celled ovary (speedily becoming one-celled by abortion), contains a single suspended ovule, which is at first orthotropous, and later becomes anatropous; that is, it becomes inverted as its development proceeds. At maturity the ovaries, still immersed in the now greatly enlarged spadix, and nearly confluent, constitute an ovoid or spherical mass, on the exterior of which remain the segments of the perianth and the vestiges of the styles.

The ripened seeds are very peculiar in many respects. Instead of containing an embryo in which the parts are easily distinguished, there exists a nearly solid mass looking like a diminutive bulb; and such it might be called. It is, in fact, what is termed a bulbiform embryo. In his *Genera of North American Plants*, Nuttall said of this seed, it "does not appear to possess anything like a proper cotyledon, the embryo formed in the exact posture of the growing plant (with the radicle downwards), differs not from it in any particular but that of size. In place of a cotyledon there is a sheathing stipule, similar to that which is ever after produced; in fact, it is viviparous." Of course the latter statement is understood to mean merely that the embryo in this case is a miniature of the adult plant, in its parts and their shape. Dr. Gray states that the seeds are "filled by the large globular and fleshy corm-like embryo, which bears one

or several plumules at the end next the base of the ovary." The seeds contain no albumen. The fruit is ripe in early Autumn. It may here be said that the generic name of this plant was given on account of the confluence of the fruits of many flowers to form a compound fruit, or in the words of Salisbury, who established the genus, "on account of its mono-spermous ovaria immersed in the receptacle exactly as in *Anana*." It should be observed that Cutler, of this country, and Robert Brown, had long before called attention to the marked characters by which this plant could be separated from the genus in which it was then included.

The spathes rise from the soil in early Spring, and are followed a short time later by a conical cluster of ovate leaves, which are heart-shaped at base, and strongly netted-veined throughout. The leaves, the bracts, the flower-cluster, and the stout root-stock from which they all rise, possess an extremely offensive odor, whence its more common name, Skunk-cabbage. In his Medical Botany, the late Dr. Bigelow, objecting on etymological grounds, to the name *Symplocarpus*, proposed the generic name *Ictodes* (from *iktis*, ferret, or weasel,) "sufficiently expressive of the property from which its common name is derived."

The livid color and the loathsome alliaceous odor place this plant in the group thought to be attractive only to carrion-flies and the like. Several observers have shown, however, that the flower-cluster is frequented by many other insects. The following account, communicated by Mr. William Trelease to

the *American Naturalist* (Sept., 1879), gives a sufficiently full and very clear statement of the matter :

If a few of the largest spathes are secured in the first warm days of spring they will probably be found already in bloom, and a moment's inspection will show us that the flowers clustered on the stalked globose spadix are proterogynous ; for while the delicate stigmas of some are protruded from the floral envelopes, their stamens are still enclosed and immature. It will also be found that the flowers which are open are those situated near the top of the spadix. These flowers, then, are ready to be fertilized, but pollen for their fertilization must be brought from another spadix. In the course of a week or two, for the rapidity of development depends in large part on the warmth of the season, the aspect of our spadix will have entirely changed, for the stigmas of the upper flowers will be withered and the stamens of these same flowers will now protrude from their envelopes and shed their pollen. Meantime the stigmas of the lower flowers have matured, and some can evidently be fertilized by the mere falling of pollen from the upper flowers without any extraneous aid, for pollen is shed in such quantities that it covers the bottom of the spathe.

On the first warm and sunny day we repair to a sheltered swampy place where we find our plant, and proceed to look for the little flies that we expect to find in the spathes, whither they should be attracted by the color and odor, and by the shelter offered ; but no flies appear. While we are looking a hive-bee alights on a spathe and enters it. Approaching, we see her busily engaged in collecting pollen, meantime creeping back and forth over the surface of the spadix, which, as well as her body, is thoroughly covered with the yellow dust. Other observations show that each spathe is daily visited by scores of hive-bees, some of which are unable to escape from the spathes and die there. A little later in the season a small bug (Hemipter) may be found in small numbers on the spadices, and they are usually well dusted with pollen. Occasionally a slug or the slimy trail of one is found within a spathe, and usually they pass

over the spadix. A couple of weeks after finding the first bee the spathes will be found swarming with the minute black flies that were sought in vain earlier in the season, and their number is attested not only by the hundreds of them which can be seen, but also by the many small but very fat spiders whose webs bar the entrance to three-fourths of the spathes. During the present spring a few specimens of a small scavenger-beetle (*Ips fasciatus*) have been captured within the spathes of this plant. What they were after I can scarcely say, but they may have been visiting spathe after spathe in search of one with a decaying spadix, for the prolonged cold and wet weather caused many to decay, or they may have been in search of flower-food.

Considering these facts, it appears that with us hive-bees are not deterred by the odor of the flowers from visiting them and collecting their pollen, and that their visits are so frequent as to render them the chief agents in securing the cross-fertilization of the flowers, at least very early in the season. Later, a few bugs and beetles may be of some use in transferring pollen, as also in a slight degree the spiders which take up their abode within or at the entrance of the spathes. Slugs and snails enter as agents for the transfer of pollen in a few cases, as might be expected from what Delpino has shown with regard to their habits in visiting plants related to this. Finally, other and more attractive flowers opening, the bees appear to cease visiting those of this species, and countless small flies take their place, compensating for their small size by their great numbers.

Symplocarpus foetidus is found in wet soil throughout Eastern North America, and a species, probably the same, occurs in North Eastern Asia.



PLATE XXVIII.

INDIAN TURNIP.

ARISÆMA TRIPHYLLUM, TORREY.

The points of dissimilarity between this plant and its near relative, *Symplocarpus* are, at the first glance, far more conspicuous than any characters by which the kinship is recognized. In *Arisæma* the spathe is much thinner, and its lower half is closely rolled up to form a tube; but at its upper part it flares abruptly into an overarching plate, beneath which, stands the long spadix. The arched roof over the spare, erect body, bears a suggestive resemblance to the old-fashioned "sounding-board" placed over a pulpit to increase the resonance of the speaker's voice; and from this remote likeness has come one of the common names of the plant,—Jack in the Pulpit.

The spathe in *Symplocarpus* is as deeply colored on the outside as it is within; in *Arisæma* the outside is generally of a dull green, faintly discolored by purple stripes, while the color within may be either green or a very dark purple.

In the spadix, however, the differences become even more apparent: in the first, the perfect flowers are crowded over the whole surface of a globular receptacle; in the latter, the flowers are imperfect and are confined to the lowest part of the spadix, which is long, slender, and club-shaped above. The plant is nearly diœcious, that is, the staminate flowers are on one plant while the pistillate are on another. Each group of flowers may be associated with reduced forms of the other sort; for instance, there are occasionally in the place of the anthers, flattened papillæ, which open much as anthers do, but which contain no pollen. In Dr. Torrey's "Flora of New York," it is stated that the flowers in the green spathes are usually sterile, and in the purple or variegated they are fertile or androgynous. By the latter term is meant an association of staminate and pistillate flowers in the same cluster. The flowers are naked, that is, they have no floral envelopes. The fertile flowers, which are below the sterile ones, are merely one-celled ovaries, having at the summit a roundish stigma, and containing in the single cell four to six erect ovules. The ovaries ripen into scarlet berry-like fruits, each of which contains from one to four seeds. The seeds are round, and have a large hilum or scar at base. The embryo is in the axis of starchy albumen.

The corm, or solid rounded root-stock, from which the leaves and flower-stalk spring, is fleshy and somewhat flattened above, and wrinkled at the sides. At its upper part it is generally covered by the membranaceous bases of the

sheaths. The corm is stored with farinaceous matter, and contains throughout an extremely acrid juice. When touched to the tongue, this acrid substance gives intense pain, which persists for a long time. The acidity is dissipated by drying, or more quickly by the action of heat, and there remains behind a nutritive farinaceous matter, from which a starch, like that of arrow-root, can be obtained. In fact, the acrid juice which is here found associated with a tasteless starch, may be compared with the more acrid and poisonous principle found in the tropical plants of the order, which yield starch in very large quantities. The plant has one or two leaves, divided so deeply that they might well be considered compound. Each of the segments of the leaf is elliptical and acuminate, and has wavy margins.

The sheathing base of the leaf-stalk is united to form a tube; and the apparent stem above ground is made up of several similar tubes, one within the other, in the middle of which rises the scape, or stalk bearing the inflorescence.

Another species of *Arisæma* grows in eastern North America, but not quite so far north as *A. triphyllum*. It is easily recognized by its single leaf, which is divided into 6-12 lanceolate segments, and by its long and pointed spadix which extends beyond the spathe.

The name *Arisæma* is said to be a play upon the older name *Arum*, probably formed of "ἄρον *Arum*, and σήμα, a sign or mark."



Drawn by Isaac Sprague

Plate XXIX.

CANADIAN ROCK-ROSE.

HELIANTHEMUM CANADENSE, MICHX.

Armstrong & Co.

PLATE XXIX.

CANADIAN ROCK-ROSE.

HELIANTHEMUM CANADENSE, MICHAUX.

In early summer the Rock-rose produces showy, yellow blossoms, which open wide in bright sunshine. Later in the season, the same plant may bear also smaller flowers, in which the parts are reduced in number as well as in size, and which do not expand at all. In some cases, the corolla is entirely wanting. It has been already said, in the description of Arrow-leaved Violet, that flowers which do not open, but remain with the stamens and pistil concealed by the closed floral envelopes, are known as *Cleistogamous*. Plants which bear two forms of flowers are termed *Dimorphous*; and when one of these kinds is reduced in structure, and does not expand for the purpose of fertilization, the peculiarity is called *Cleistogamous Dimorphism*.

The calyx in the early blossoms of Rock-rose consists of five lanceolate sepals, of which two are so small, and

so disposed with respect to the other three, that they are, perhaps, as suggested by Dr. Gray, to be regarded as bractlets. The five broad, wedge-shaped petals are of very delicate texture, and last only a single day. The list of ephemeral flowers, or flowers of a day, is much longer than might be at first suspected; for many of the plants bearing such blossoms are decorated on successive days with about the same number of fresh flowers, and thus it might appear that the individual blossoms had persisted for a longer period.

The early flowers of Rock-rose usually possess a large number of stamens, though sometimes only fifteen or twenty, inserted with the petals upon the receptacle, and falling at about the same time as the corolla. The pistil has an ovoid ovary, which is surmounted by a short style and a three-lobed stigma. Sometimes the placentæ, the parts which bear the ovules, project so far into the ovary as to make it imperfectly three-celled. The ovules are orthotropous, and droop from slender, thread-like stalks. The fruit is a capsule, which breaks at maturity into three valves, each of which has the placenta in its middle line.

The seeds have a curved embryo in farinaceous albumen.

The slightly branched stems have narrow, elliptical leaves, which are generally opposite below, and alternate above. In their axils, the earlier, or primary, flowers are solitary; the later, secondary ones, are in small clusters.

The leaves are more or less pubescent, and frequently have minute dots of a resinous substance, probably of the same nature as the exudation abounding in some species of a nearly allied genus, *Cistus*, and known as gum Ladanum. The order *Cistaceæ*, to which the Rock-rose belongs, comprises about sixty species, occurring, for the most part, in the Mediterranean region of Europe; but two of the four genera are exclusively American.

The name Rock-rose belongs more properly to the species of *Cistus*, but is in common use in some parts of the country. The plant is also called Frost-weed, a name based upon the fact that in "autumn, crystals of ice shoot from the cracked bark at the root." The generic name comes from *ἥλιος*, the sun, and *ἄνθεμον*, flower.



Drawn by Isaac Sprague

Plate XXX.

BUR - MARIGOLD.

BIDENS CHRYSANTHEMOIDES, MICHX.

Armstrong & C

PLATE XXX.

BUR-MARIGOLD.

Bidens Chrysanthemoides, Michaux.

The vast Order Compositæ, containing about ten thousand species, is divided into tribes, based upon the character of the corolla, the branches of the style, and the calyx-like involucre which surrounds the head of flowers. When the entire order is taken into account, the tribes are to be divided into sub-tribes, and the latter into minor groups, or alliances, based upon minor features. When, however, the Compositæ of a limited section are to be considered, other divisions than those just mentioned are made for convenience. For instance, in the *Manual of the Botany of the Northern United States*, Dr. Gray has arranged the genera of the Order in tribes and sub-tribes, which are, for the most part, very clearly distinguished from each other; but in grouping the genera of this Order throughout the whole country, it would be necessary to change the divisions in many particulars. Thus it happens that the tribal and sub-tribal names in different treatises are used with a different range, if not with a different signification. This is illustrated by the plant of the present plate. *Bidens*, or Bur-marigold, is placed by Dr. Gray in the Senecionidiæ, and the sub-tribe Helianthæ: in Bentham and Hooker's *Genera*, in which the genera of the

whole world are considered, the genus *Bidens* is referred to the tribe Helianthoideæ, and the sub-tribe Coreopsideæ, to which the genus *Coreopsis* belongs. A glance at the *Manual* will show, however, that *Coreopsis* is given by Dr. Gray the very next place in linear sequence to *Bidens*, and thus their relationship is clearly implied. It may be said, in passing, that the well-known genus *Dahlia* is very closely allied to the two just mentioned.

Bidens is not very far removed from the genera *Rudbeckia* (*Lepachys*) and *Echinacea*, described in detail on page 111. Only the chief marks of difference will be indicated. The receptacle in the latter is elevated, sometimes very conspicuously, into a cone or column, and there is no free border to the calyx, or, at most, it exists as a minute crown-like appendage. In *Bidens*, on the contrary, the receptacle is flat, and the achenia are surmounted by a pappus of two, or sometimes more, firm sharp teeth, which are barbed downwards. The large species figured in our plate has rather longer barbs to the teeth than those occurring in the other common plants of the genus. It is a swamp herb, from half a foot to two or three feet in height, smoothish throughout, and bearing a few large showy heads, with ray-flowers an inch in length. The leaves are lanceolate, somewhat united at the base (connate), serrate, and acuminate.

Bidens cernua is a closely allied species, which can be distinguished with difficulty by its leaf-margins, which are more irregularly serrate; and by the rays, which are generally smaller,

(sometimes they are wholly absent). The intermediate forms make it very probable that the two species should be referred to one.

Bidens cernua occurs in wet places throughout Europe, and is not distinguishable in any important respect from some forms of the plant as it grows here.

The genus *Bidens* contains about fifty species, widely distributed in tropical and temperate regions, and extending even into the Arctic zone. According to Mr. Bentham, there are three species in the Chilian region, twenty in the "Andine," twelve in the Brazilian, five in the West Indian, sixteen in the Mexican, and seven in the United States. Two species are stated by him to be weeds of cultivated and waste places, of American origin, and now established in most warm countries through the qualifications they possess, namely, the abundance and the adherence of the fruits.

By their barbed teeth, the fruits cling, as with tiny grappling-hooks, to clothing, to the fleece of animals, and to plumage. The genus derives its Latin name from the two teeth by which its dissemination is effected.



Drawn by Isaac Sprague

Armstrong & Co. Lith.

MEADOW BEAUTY.

Plate XXXI

RHEXIA VIRGINICA L.

PLATE XXXI.

MEADOW BEAUTY

Rhexia Virginica, L.

The tropical order, *Melastomaceae*, comprises one hundred and thirty-four genera, but of these only one genus is found much beyond the tropics.

The genus *Rhexia*, represented by the "Meadow Beauty," figured in Plate xxxi, occurs only in the temperate regions of Eastern North America.

The plants of this genus are among the humbler in the order, nevertheless they serve very well as a type of it. The most conspicuous character seen at the first glance is one which extends very generally throughout the whole family,—the peculiar veining of the leaves. There are from three to nine strong ribs, which are often connected by cross veins nearly parallel to each other. In the small sessile, lanceolate leaves of common "Meadow Beauty," there are usually only three such ribs. Some of the larger species in the order, which are among the choicer treasures of the conservatory, owe their attractiveness in great measure to the showy foliage.

A second striking characteristic is found in the anthers, which in most of the genera are long and somewhat curved, and are frequently provided with a noticeable appendage of some sort, derived from the connective. In the species of *Rhexia* the stamens are shorter than the petals, and they do not all possess the appendages observed in many of their relatives. In this species, however, near the point where the anther is united to the filament which bears it, there is a short and slender process, somewhat recurved, appearing like a minute spur at the back of the connective. The pollen consists of extremely minute grains which escape through a pore at the apex of the tapering anther. In Nuttall's Botany, the statement is made that the anthers emit their pollen through a single clandestine pore, situated at the junction of the anther with the filament, "the pore guarded by a single seta."* The anthers are inverted in the bud.

The plan of the flowers is suggestive of the Evening Primrose family, (represented in this work by *Gaura Lindheimeri*). In *Rhexia* the numerical plan is four: the stamens being in two rows of four each. The ovary is four-celled, the many ovules attached to rather prominent placentæ. In fruit, the smooth, roundish pod remains covered by the somewhat inflated and glandular calyx, from which it is usually nearly or quite free. The seeds are cochleate, or

* Nuttall's *Genera of North American Plants*, p. 243.

coiled like a snail-shell, and have a deep depression in the centre. The embryo is not surrounded by albumen.

Rhexia Virginica is a perennial herb, with a square stem, somewhat winged at the angles which are ciliate or bristly. The leaves are also hispid or bristly at their margins. The stem is forked above, and bears a cluster of large flowers of a bright purple color. The clusters would be even more attractive, if a larger number were open at one time, but it is unusual to find more than four in full bloom at once.

The plant is common in sandy swamps through the United States, east of the Mississippi.

In cultivation it is one of the most desirable of our common wild flowers, and needs very little care.

PLATE XXXII.

PASTURE THISTLE.

Cnicus pumilus, Torrey. *Cirsium pumilum*, Sprengel.

The Thistles are not by any means unattractive plants. Bristling as they do with such obvious weapons of defence, they frequently are left among the last survivors in the well-grazed meadow, and even our native species can often encroach upon ground which is otherwise filled with the pertinacious weeds from foreign countries. But that one of the thistles which is more widely known as a weed in this country, and which has received the name "Canada Thistle," is a native of the Old World, and is only an intruder here.

The word Thistle is derived from an Anglo-Saxon word of nearly the same pronunciation, and is allied to the German Distel, and to the name of the well-known Teasel. The word has been applied to a large class of plants, some of which have little in common with the true Thistles, except the prickly character of the leaves and stems. In many



Drawn by Isaac Sprague

Plate XXXII

PASTURE THISTLE.
CNICUS PUMILUS, TORREY.
(*CIRSIIUM PUMILUM*, SPRENGEL.)

Armstrong & Co. Lith.

cases the word is used with a prefix, as in Star-thistle, Blessed-thistle, Sow-thistle, and Scotch, or Cotton-thistle.

Star-thistle is a species of *Centaurea*; Sow-thistle is *Sonchus*, and is closely allied to the Lettuce; Scotch-thistle is *Onoropordon Acanthium*. In Gerarde's description of this plant the following account is given of its appearance: "It is set full of most horrible sharp prickles, so that it is impossible for man or beast to touch the same without great hurt or danger." How well its spines for its own defence served once for the defence of the people which have adopted it as a national emblem, has been told by a writer in the following words: "When the Danes invaded Scotland, it was deemed unwarlike to attack an enemy in the darkness of the night instead of a pitched battle by day; but on one occasion the invaders resolved to avail themselves of stratagem, and in order to prevent their tramp being heard, they marched barefooted. They had thus neared the Scottish force unobserved, when a Dane unluckily stepped upon a sharp Thistle and uttered a cry of pain, which immediately aroused the Scotch, who discovered the stealthy foe, and defeated them with great slaughter. The Thistle was at once adopted as the emblem of Scotland."

The true Thistles are referred by Mr. Bentham, in the "Genera Plantarum," to the genus *Cnicus*, instead of the one which has hitherto held its place in most of the popular Floras, namely, *Cirsium*. In Dr. Gray's revision of the "North American Thistles," the generic name *Cnicus* has

supplanted the other, and the species known as *Cirsium mutilum*, is given as *Cnicus mutilum*.

The species for which this might be mistaken is the common Swamp Thistle, from which it differs in possessing bracts at the base of the flower-heads, and in having the involucreal scales with rigid points instead of mostly slight and glutinous ones.

The leaves are somewhat hairy, especially on the strong midrib, and on the under side. They are partly clasping, and irregularly cut into segments which are themselves variously cut or lobed, and which are very sharply pointed.

Pasture Thistle has a lower stem than any it would naturally be mistaken for, and it bears in general fewer heads. The fragrant flowers are tubular, as are all the flowers in the species of this genus, but from their somewhat flattish appearance in the outer rows, they might at the first glance be thought to be radiate.

It sometimes happens that the flowers are whitish instead of rose-purple color, which is far more common in all the species.

Pasture Thistle occurs very frequently in dry fields near the Atlantic coast, and also extends westward.

The Generic name is derived from the Greek word *κνίζω*, to prick.



BLOOD-ROOT.

SANGUINARIA CANADENSIS. L.

Arnica & Co. Lith.

PLATE XXXIII.

BLOOD-ROOT.

Sanguinaria Canadensis, L.

From the terminal buds of the thickened underground stems of this plant, there arises in very early Spring a flower-stalk, bearing, as a rule, only a single blossom. For a while the stalk and the flower are partly enveloped by a roundish leaf, which subsequently unfolds and increases greatly in size.

Upon, or just before, expansion of the erect flower-bud, the two sepals fall (caducous). This indeed is the case generally in the plants of this Order, Papaveraceæ. After the loss of the two ovate sepals, the eight to twelve conspicuous white petals, constituting, apparently, a single series or whorl, might naturally be mistaken for the Calyx of an apetalous flower (compare the flower of *Clematis*, page 65). Inasmuch as one of the earliest questions to be determined in the ordinary analysis of a flower is the presence or absence of the corolla, it is advisable in all doubtful cases to have a young bud for examination. Moreover the character of the cells of the anthers can be

made out more clearly in a bud than an expanded blossom.

The petals of Blood-root appear at the first glance to be arranged in one whorl, as stated above, but they are really in two or three series, those of the inner being somewhat smaller and narrower than the outer. In the bud, unlike those in many other plants of the order, they are not crumpled. There are twenty to thirty stamens, usually twenty-four, all considerably shorter than the petals. Their filaments are thread-like, and bear linear anthers which open longitudinally.

The pistil is composed of two carpels. The ovary is oblong, one-celled, with many ovules on the two parietal placentæ. At maturity, the two sides or valves separate, at first below, from the persistent placentæ which, arched above, remain in place as a sort of frame (termed a *replum*, from the Latin word for door-case).

The seeds are smooth, and at the raphe, or ridge on one side, are very plainly crested. By far the larger number of flowering plants possess inverted or anatropous ovules. In such cases, the funiculus or thread by which the ovule is attached to the placenta, is coherent with the side of the inverted body, and constitutes, as in this instance, a cord or ridge down its whole length. This adherent thread is often a conspicuous ridge, but it is sometimes so completely incorporated with the body of the ovule, that it hardly disturbs the symmetry of the ovoid mass.

The whole plant is filled with an acrid, reddish-orange juice which flows freely when the root-stalk, leaf-stalk, or scape, is cut or bruised. The plant derives its popular as well its scientific

name from the color of its juice (the latter from the Latin *sanguis*, blood).

In the case of nearly all plants from which a white or colored juice exudes, there is a special system of microscopic canals consisting either of branched cells or of confluent tubes, termed the Latex system. Thus in the Euphorbias, Lettuce, and Papaver or Poppy, the milky juice is contained in communicating Latex-tubes. But, in some other cases, for example blood-root, the colored juice is held in receptacles of a different character. In blood-root these special receptacles are roundish or much elongated, and possess very thin walls. While some of these cells or sacs are separated from one another, others are arranged in rows. This grouping into linear series is well-marked in the more superficial parts.

Blood-root has been much used in medicine, having had a wide reputation as an expectorant.

The plant grows freely in rich soil, especially near the borders of open woods. It occasionally varies in its habit, or mode of growth, and species have been based upon such forms, but they are now all referred to the single species, *Canadensis*, by which the genus is represented.

It is said by several writers that the plant was formerly used by the Indians as a dye, and it was one of the plants known as Puccoon. From its rich yellow, it has also received the name *curcuma* or turmeric, which belongs to an entirely different plant.¹

¹ Tota planta luteo tincto succo ad tingendum apto. Pocan indigenis dicta et a veterinariis Americanis haud inepte *curcuma* vocatur (herb. Vaill.) De Candolle Systema, vol. II., p. 89, 1821.



CLIMBING HEMP-WEED,
MIKANIA SCANDENS WILLD.

ARMSTRONG & CO. LITH.

PLATE XXXIV.

CLIMBING HEMPWEED.

Mikania scandens, L.

The plants of the order Compositæ, described on pages 21 and 43, possess clusters of many aggregated flowers which bear a close resemblance to large single flowers. In the present instance, the clusters or heads contain only four flowers; each cluster is surrounded by a whorl or involucre of four small and narrow bracts. The receptacle is small and free from chaff. The corollas are all tubular and five-toothed. The pappus, or free border of the calyx, consists of a single series of delicate, capillary bristles, which are slightly roughened, and in some species of the genus, are united into a ring at the base. The five-angled achenia, or fruits, are flattened at the top.

The small flower-clusters are grouped into rather close, paniculate cymes, and by their mass of pale, fresh-colored blossoms, opening in mid-summer, form with the bright green leaves attractive combinations. The leaves are opposite, stalked, triangular, or more or less cordate, with somewhat coarsely-toothed

margins. The stems are branched and twining, entangled among thickets by the sides of streams.

The genus *Mikania*, dedicated to Professor Mikan of Prague, comprises sixty species belonging to the warmer parts of America, Africa, and Asia. The species here figured is found through the United States, east of the Mississippi River.



Drawn by Isaac Sprague

Armstrong & Co. Lith.

SWAMP ROSE.

Plate XXXV

ROSA CAROLINA L.

PLATE XXXV.

SWAMP ROSE.

Rosa Carolina, L.

The calyx-tube in the case of the true Roses is globose, or urn-shaped, and somewhat constricted at the mouth. Its border possesses five spreading, leafy calyx-lobes, and its internal surface bears numerous hairy ovaries. Of course, it is to be assumed that a film of receptacle lines the calyx-tube; and it is upon this film that the ovaries are borne.

In another view of this structure, it is held that the so-called calyx-tube is an enlarged receptacle, excavated for the reception of the ovaries, and furnished at its border with five sepals: the hollowed body is termed a receptacular tube or cup. The same view, applied to ordinary inferior ovaries, leads to the assumption that the calyx begins only at what has been hitherto regarded as its free border, and that the enveloping body is receptacle only. The latter view is taught in many text-books,* but the former is the one generally held by descriptive writers.

* *A System of Botany*. LeMauot and DeCaisne, p. 75. *Text-Book of Botany*. Sachs, p. 489.

In the Order Rosaceae the receptacle assumes very different forms. Thus, in the true Roses it is cup-shaped, or at least lines a cup-shaped cavity, (whether the cup be calyx-tube or not,) but in strawberries it forms, on the other hand, an enlarged, conical, pulpy mass, the bulk of the edible "fruit." In the latter case, the enlarged receptacle bears on its surface the minute ovaries which ripen into seed-like fruits (achenia). Quinces, which belong to the same order, have for their "fruit," a "calyx-tube" which has grown into an enlarged mass of firm texture. Pears and Apples, which are closely allied plants, have an enlarged calyx-tube lined with what is obviously a thickened receptacle. In fact, all the fleshy mass that is found within the circle of green dots, which appear in a cross-section, belongs to the receptacle. The true fruits, or ripened ovaries, of pear, apple and quince alike, are the five, tough, parchment-like cells which make up the core.

It is not unusual, particularly in cultivated roses, to notice a marked difference in the size of the calyx-lobes. In such cases it will be seen that the lobes do not successively diminish in size around the circle, but that the largest has a next larger two-fifths of the circle removed, and so on. A similar curious two-fifths relation of the metamorphosed leaves of the calyx to the two-fifths relation of the foliage leaves of the plant can be seen in the parts of many flowers. The petals and the many stamens are inserted upon the edge "of the hollow, thin disk that lines the calyx-tube and bears within the numerous pistils below."

The five petals of the Rose are broad, and do not differ materially from each other in size or shape. In double Roses the whorls of petal-like expansions are very numerous, and are regarded as metamorphosed stamens and pistils.

It sometimes happens that from the central part (the axis) of the Rose there extends a prolongation bearing floral organs, (this is a deviation termed proliferation,) or the greater part of the flower may become less delicate and assume a distinctly green color, thus forming the so-called "Green Rose." The disease is known as chlorosis.

Under cultivation, and by careful crossing, innumerable varieties of roses have been produced. Only one of the United States species has ever passed into general cultivation. This is *Rosa setigera*, a prickly but not bristly, climbing plant, commonly known as the "Prairie Rose." Another climbing rose might be thought from its name to be a native plant, namely, the so-called Cherokee Rose, which runs wild in the Southern States. It is, however, a native of China, and has become naturalized at the South.

Roses appear to have been cultivated from the earliest times. Professor Koch, in his Lectures upon Dendrology, says that they were planted long before it became the custom to surround gardens with walls. He further says that "each of the four great peoples in Asia possessed its own variety of rose, and carried it during all its wanderings, until finally all four became the common property of the four peoples. The great Indo-Germanic stock chose the 'hundred-leaved'

and Red Rose (*Rosa Gallica*); nevertheless, after the Nibelungen, the common Dog-rose (*Rosa canina*) played an important part among the ancient Germans. The Damascus Rose (*Rosa Damascena*), which blooms twice a year, as well as the Musk Rose (*Rosa moschata*), were cherished by the Semitic or Arabic stock, while the Turkish-Mongolian people planted, by preference, the Yellow Rose (*Rosa lutea*). Eastern Asia (China and Japan) is the fatherland of the Indian and the Tea Roses. In very early times the latter were brought to the Indies. . . . Thus they obtained the erroneous appellation of the Indian Rose." *

The stems of the Swamp Rose are armed with strong, recurved prickles, which are not true thorns, or modified leaves or branches, but are merely superficial or epidermal structures which come off when the bark is removed. The leaves have five to nine leaflets, these not shining on the upper surface as in the allied species, *Rosa lucida*,† or Dwarf Wild Rose. The flower-stalk and calyx are more or less bristly, and this character persists even after the fruit has ripened. The fruit of *Rosa lucida* is smooth when ripe.

The Order *Rosaceae* contains one thousand species, and the genus *Rosa* thirty species, of which about one-third are found within the limits of the United States.

* Koch, *Vorlesungen über Dendrologie*, p. 10.

As described in Gray's Manual, including also *Rosa nitida*.



Drawn by Isaac Sprague

Armstrong & Co. 1885

Plate XXXVI

PURPLE AZALEA,
AZALEA NUDIFLORA, L.

PLATE XXXVI.

UPRIGHT WILD HONEYSUCKLE.

Rhododendron nudiflorum, Torrey. *Azalea Nudiflora*, L.

Professor Gray, in the Synoptical Flora of North America, has merged the species of *Azalea* in the genus *Rhododendron*, of which they now constitute a series or section. The well-known *Rhodora* has likewise been placed in the same series, thus losing its rank as a separate genus. Not only does the genus, as thus made up, comprise forms which, at first, seem to be widely diverse, but it comprehends also innumerable varieties.

Artificial hybridization between the different species of the genus has been extensively practised for the production of new varieties. The species now under consideration has been largely employed for this purpose, and many beautiful hybrids are in cultivation. A true hybrid is the result of fertilizing the ovules of one species by pollen taken from another species; but the term "hybrid" has also been applied to the offspring produced by crossing a marked variety of a

species by another variety of the same species. The latter is the method commonly employed by horticulturists who are endeavoring to obtain new and improved varieties by crossing two varieties of the same species. In the case of species of the genus *Rhododendron*, hybrids between varieties, and true hybrids between species, are very numerous.

Hybridization is brought about by the careful removal of the anthers from an unopened bud, followed, upon blooming of the flower, by the deposition upon the stigma of pollen taken from another allied species. The range of hybridizing and the limits within which its results are satisfactory in the origination of desirable varieties, are very different in different families of plants. In numerous cases recorded by experimenters, the resultant varieties have possessed no marked advantage, either as regards strength or beauty, over either parent. But in a large number of instances, notably among the species of *Rhododendron*, hybridizing has produced more brilliant flowers, and imparted greater vigor and endurance to the offspring. Hybrids do not, however, as a rule, produce as many or as strong seeds as do the parent plants themselves.

The fine hybrid *Rhododendrons* in wide cultivation are derivatives from species native in the Himalaya Mountains, and in the mountains of the Atlantic States.

Within the limits of the United States, fifteen species of *Rhododendron* have thus far been detected. Of these, five are true *Azaleas*, and are characterized by having a corolla with a funnel-shaped tube, and a somewhat irregular

border. For the most part they have only five stamens; true Rhododendrons, as a rule, have ten.

The species figured in the plate has a rosy, or purple, five-lobed corolla with a tube about as long as the lobes. Beyond the spreading lobes, the five to ten stamens are considerably exserted. Their anthers are rather short, and shed their pollen through terminal pores. The fruits are dry five-celled pods which break into five valves. The seeds are numerous and minute, resembling small scales.

The leaves are oblong or obovate, pubescent underneath, and deciduous; the true Rhododendrons have evergreen leaves. At, or somewhat before, the time the leaves expand, the flowers appear, being developed from conspicuous scaly buds. In some other true Azaleas the buds unfold only after the leaves are well developed, but in this species and in the magnificent Flame-colored Azalea of the Southern States the flowers precede the leaves or appear with them. Dr. Torrey says of this species, that the flowers are "in terminal clusters, about as large as in the common Woodbine,* usually appearing before the leaves expand, and hence appearing naked." It will be noticed that the specific name, *nudiflorum*, is expressive of the fact mentioned in the last clause of the quotation.

The generic name, Rhododendron, is derived from the Greek for Rose-tree; Azalea comes from the Greek for parched or dry, of no obvious application, indeed, to our species,

* Or *Lonicera*.

which grow in swamps, or along streams. The name is, however, very significant when applied to the two Lapland plants on which Linnæus founded the genus. Of one of these two plants, now referred to another genus, *Loiseleuria*, he says: "No plant is more abundant in our Alps than this tiny shrub, which covers the vastest Alpine tracts, provided the place is sterile, dry, and sandy." (Translated from *Flora Lapponica*, Linn., 1737, p. 58.) Nor is the name hardly less appropriate when applied to the Alpine Rhododendron, which Linnæus termed Azalea.

The common name, "Upright Wild Honeysuckle,"* is that given in Dr. Torrey's "Botany of New York;" an associated species, *R. viscosum*, being called "White Wild Honeysuckle." Another common name—in books—is Pinxter-flower, from the time of blooming (Pinxter, or Pingster, from the German Pfingsten, being Pentecost or Whitsunday, the seventh Sunday after Easter).

* It is, of course, to be remembered that the name "honeysuckle" has been applied to several plants, e. g., *Lonicera*, *Trifolium*, and even *Aquilegia* (see page 6), having in all these cases reference to the saccharine matter found either in the flower, or, in some species, upon the leaves.



PLATE XXXVII.

MAY-FLOWER.

Epigæa repens, L.

IN the first days of April, and sometimes earlier still in sunny places, a few of the flower-buds of this plant are fairly open, and these are followed by a succession of blossoms through the month. In sheltered localities some of the flowers may be found even in the last of May, but as a rule the plant is an April rather than a May flower. The popular name by which the *Epigæa* is generally known, has in the old world been bestowed upon other and very different plants: thus the May-flower for which the ship of the Pilgrims was named, was, in all likelihood, a thorn blooming in May. A second popular name, referring to its prostrate and creeping habit, is "Trailing Arbutus." The genus *Arbutus* (the name is to be pronounced with the accent on the first syllable) is allied, but not very nearly, to the May-flower. The principal species of the genus *Arbutus* is *A. Unedo*, the "Strawberry-tree," so called from the resemblance of the fruit.

The flowers of *Epigæa* are in small compact clusters which appear to be axillary, and are frequently described as such, "arising from the axils of the older leaves." The clus-

ters are nevertheless terminal, as inspection of the plant in midsummer plainly shows. At that time the withered flowers of the previous spring can be found upon the browner branches, while from the base of the small flowering shoot, and in the axil of a leaf, arises the new, strong, leafy shoot, with its small but already well-formed buds half concealed by the bracts. These buds are clustered at the end of the new branch; just below them, and well developed, occurs a leaf which may, later on, aid in giving the illusory appearance of axillary inflorescence.

The stems are trailing, slightly shrubby, and irregularly branched. The older branches are dark brown and decidedly woody, and are generally roughened by the exfoliating epidermis, or outer pellicle of bark. The newer shoots are covered with rusty hairs, which abound also on the petioles and the upper surface of the leaves. The leaves are alternate, elliptical, for the most part heart-shaped at base, and with nearly entire margins. They are thinnish, and yet somewhat tough or coriaceous in texture, and they remain green throughout the winter. From the character of the foliage, perhaps, as much as from that of the flowers, the plant has been called "Ground Laurel." The leaf-blades are finely-reticulated with whitish veins, which are very conspicuous when the leaf is held up to the light, and at length become somewhat prominent upon the upper surface, making it decidedly rough to the touch.

The calyx is made up of five pointed, lanceolate segments,

which are scale-like and about as long as the bracts, which they closely resemble. Even in the brown and withered flowers found in summer, the bracts and the calyx-segments are still recognizable. The salver-shaped corolla is a trifle longer than the calyx, and its five lobes are oval and more or less spreading. The tube is bearded within.

The ovary is five-celled, and contains many ovules. Upon ripening, it becomes a many-seeded capsule of nearly globular form, somewhat flattened at the summit, and obscurely five-angled or lobed. It is hairy, and generally crowned by the withered and persistent style. The ovoid seeds are borne on prominent placentæ and become exposed by the separation of the valves of the pod, the divergent placentæ remaining attached to the axis.

The relative lengths and general characters of the ten stamens and of the style present some curious variations and peculiarities which must be noticed in detail. These variations are so very frequent that from one limited locality, in a sea-shore wood in Maine, no less than seven different forms have been distinguished, the only noticeable differences in the corolla being those of color, and these differences in tints not related to differences in the arrangement of the reproductive organs. In all cases the style is slender and at its summit has a ferule or ring, to which the stigma-lobes are adnate. In one class of flowers the stamens are of good length and their anthers are fully developed; but although possessing well-developed and pollen-bearing anthers, they

have only short stigmas. The style is sometimes longer than these perfect stamens, sometimes of the same length, while in still other cases it is shorter and covered by them. But these flowers with good stamens very rarely, if ever, produce fruit.

Upon other plants than those just described the stamens are imperfect, rudimentary, or even absent altogether. Nevertheless, such flowers have, as a rule, stigmas with longer stigma-lobes exceeding the ring, radiating and viscid. Thus they are, by their greater length, their spreading, and their glutinous character, adapted to catch and retain pollen, if it should by any chance be received from other blossoms. The May-flower seldom produces good fruit. In the cases where it has been detected, the persistent style possessed stigmas of the form now described.

When a plant has flowers of two sorts, one with long stamens and short styles, the other with short stamens and long styles, so that the two sets are exactly correlated as regards length, it is termed dimorphous. The Partridgeberry, or *Mitchella*, is a case in point. If there are three correlations of length, so that there are present in one flower stamens of two lengths and a long style, in another the same kind of stamens with a short style, while still a third possesses a style of length midway the other two, and the stamens of two lengths, the species is said to be trimorphous. To species in which there are numerous relations of length, the term heteromorphous is appropriately applied.

What has been said about the different forms of the species here figured will also show why it has been regarded as in some instances diœcious.

The range of this plant is wide, extending from "Newfoundland westward to Saskatchewan, and south to Kentucky and Florida." Its local distribution is governed largely by the character of the protecting vegetation, and to a great extent by the soil; thriving in light sandy and gravelly lands, but found also in clayey earth. Even when the soil in which the plants are growing thriftily is removed with little disturbance to a garden, the plants soon become less vigorous, and after a year or two slowly die out. The species has been grown with a good degree of success by a few experienced cultivators, but they appear to agree in regarding it as an exceedingly capricious plant under cultivation.

The genus contains two species; a second and closely related one,—*Epigaea Asiatica*, Maxim.,—occurring in Japan. The specific name, *repens*, refers of course to its prostrate and creeping habit.



Drawn by Isaac Sprague

Plate XXXVIII.

WATER LILY.

NYMPHÆA ODORATA, AIT.

Armstrong & Co. 1

PLATE XXXVIII.

SWEET-SCENTED WATER-LILY.

Nymphæa odorata, Ait.

THE stems of our Water-lilies consist of submerged rhizomata or root-stocks (see page 31, under Iris). The true lilies are, as already stated, monocotyledonous plants, and their stems are distinctly endogenous; the strengthening tissues, the bast-fibres, being scattered throughout in an apparently irregular manner. The stems of most dicotyledonous plants are, on the contrary, exogenous, having their bast-fibres arranged in a cylinder, within which lies the wood as a shaft, and around the whole the outer bark is wrapped. In herbaceous dicotyledons the wood exists generally in a soft and sometimes almost unrecognizable state, but as a rule there is a distinction to be clearly made out between the bast and the wood, and they are not arranged together in fibres scattered throughout the whole mass of the stem.

In the Water-lilies, however, which are dicotyledonous plants, the stem is only obscurely exogenous; it resembles rather that of some monocotyledons, and might easily be mistaken for endogenous structure. The stems are perennial both in the sweet-scented or eastern species and in the

western scentless *Nymphaea tuberosa*. In the case of the latter, however, the rootstocks have also tubers, which sometimes become detached.

From the submerged rootstocks, which are generally imbedded in soft mud, there arise long petioles bearing round blades, which float upon the surface of the water. At the base of the petioles are broad stipules.

The leaf-blades are cleft at base, and have entire margins; the under surface differs usually in color from that above. It may here be noted that while in leaves which possess an upper and an under surface there are generally far more stomata or microscopic breathing pores below than above, in the case of water plants with floating leaves there are no stomata below.

The flowers are single, and are borne on long flower-stalks, which bring them to the surface of the water. Here they open in early morning and close at nightfall. The four sepals, green on the outside, are nearly distinct from each other. The petals are very numerous, and are arranged in many series, the inner petals smaller, and becoming more and more like stamens, each inner one tipped with anther-cells; while the outer of the many stamens have broad filaments, and grade completely into narrow petals. The transition from one to the other is very instructive.

In both our species the petals are white, in the eastern one varying occasionally into rose or pink. The eastern species is also very fragrant, while the *Nymphaea tuberosa* is

wholly scentless. The pistil is made up of many carpels or pistil-leaves, which unite to form a many-celled ovary. It has been said regarding the carpels in the other plants described in this series that the ovules are borne upon the united edges of the folded pistil-leaf, the so-called ventral suture. In Water-lilies, on the contrary, the ovules are found scattered upon the inner face of the wall of the ovary, *except at the ventral sutures*.

The upper part of the pistil consists of a flattened surface, depressed somewhat, but having in its very centre a minute globular mass, from which there radiate projecting stigmas.

The seeds are enveloped by a sac-like pulp or aril. The round fruit ripens under water, and is usually covered by the remains of the decayed petals.

The genus *Nymphæa* comprises about twenty species, mostly in the waters of the Northern Hemisphere. The colors of the species range through shades of blue and rose, and many of the plants are favorites in cultivation.

The gigantic *Victoria regia*, a native of Brazilian waters, is nearly allied to the humbler Water-lilies.



Drawn by Isaac Sprague

Armstrong & Co. Lith.

YELLOW STAR GRASS.

Plate XXXIX.

HYPOXYS ERECTA, L.

PLATE XXXIX.

YELLOW STAR-GRASS.

Hypoxis erecta, L.

THE order *Amaryllidaceæ* comprises a large number of plants in extensive cultivation; for instance, the well-known Snow-flake and Snow-drop, the Daffodil, Narcissus, and Jonquil, the Agave and Amaryllis. Only a few plants of the order are, however, native in the United States. One of the most common of these, growing in open fields throughout the east, has been selected by the artist as a representative of the family.

Upon a slender scape which rises from an underground solid bulb or corm are borne a few greenish-yellow blossoms. Around the scape are clustered several hairy, grass-like leaves, which are longer than the flower-stalk itself. The parts of the flower are arranged upon the plan of three, and the six parts of the perianth are adherent to the ovary. The superior perianth is the chief mark of distinction between this order and the *Liliaceæ* (see page 25). The stamens have sagittate anthers which are introrse and erect. In some of the other genera of the order the stamens are versatile.

The ovary is three-celled, and contains roundish ovules, which ripen into globular seeds. The seeds are described as "imperfectly anatropous, the rhaphe not adherent quite down to the micropyle, the persistent seed-stalk thus forming a sort of lateral beak." In the case of seeds which are completely anatropous, the seed-stalk is adherent down the side, forming a projecting ridge (the rhaphe), and this extends quite down to the micropyle of the seed, which is the opening in the seed-coats. The micropyle in the seed answers, of course, to the foramen or aperture in the ovule, and at maturity is generally completely closed.



Drawn by Isaac Sprague

Armstrong & Co. Lith.

BLUE STEMMED GOLDEN ROD.

Plate XL

SOLIDAGIO CAESIA, L.

PLATE XL.

BLUE-STEMMED GOLDEN-ROD.

Solidago cæsia, L.

THE eighty or more species of the genus *Solidago* are nearly all North American. Like their near of kin, the Asters, the Golden-rods present so many intermediate and puzzling forms that the species are difficult to identify. The points upon which chief reliance is placed for their discrimination are, for the most part, minute, such as the characters of the scales of the involucre, the shape and veining of the leaves, and the relative length of the outer or ray-flowers. It is believed, however, that a somewhat detailed description of a single plant of the genus will enable a beginner to use these characters for determining the better marked species.

The flowers of the Golden-rods are in small heads, each of which is surrounded by an involucre made up of a few more or less closely appressed scales. Each head has, as a rule, fewer ray-flowers than disk-flowers. The heads are clustered in many ways; in *S. cæsia* the clusters are in the axils of the leaves; in "Fragrant Golden-rod" they form collectively a

sort of panicle; and in some other species they constitute an irregular corymb. The inflorescence forms no exception to the general statement respecting Compositæ that the flowers in the heads develop centripetally or after the indeterminate order, while the clusters themselves develop from above downwards or after the determinate order, and this must be borne in mind in interpreting the terms raceme, corymb, and panicle as applied to the arrangement of the clusters. Their development as a whole is cymose or determinate, and, strictly speaking, should be so described.

The receptacle bearing the flowers is small, and has no chaff or minute bracts behind each flower. The pappus or free border of the calyx is simple and composed of capillary threads or bristles. The ray-flowers are small and pistillate. Like the disk-flowers they are yellow, except in one of our commonest species, in which they are only faintly yellow and very often are pure white. The common species just referred to, *S. bicolor*, is a member of the same group as *S. cæsia*, but differs from it not only in color but in its petioled leaves and less serrate margins of the leaf-blades. In both species the leaves are feather-veined, without conspicuous nerves or ribs at base. In another group the leaves are distinctly three-ribbed; in another they are less plainly three-nerved.

The stem of *S. cæsia* is terete and branched; its surface is smooth, and often has a conspicuous glaucous bloom. In *S. bicolor* the stem is covered with grayish hairs; in *S. latifolia*, a closely allied species, the stem is distinctly angled.

Therefore it is not difficult, generally, to distinguish this species from the other two which with it compose the group characterized by having the heads clustered in the axils of the feather-veined leaves.

This plant is found in moist thickets and woodlands, and is one of the prettiest species of the genus.



PLATE XLI.

CARDINAL-FLOWER.

Lobelia cardinalis, L.

THE bright scarlet flowers are single in the axils of the upper and much-reduced leaves, and near the summit are so closely crowded together that they may be said to constitute a raceme. The cluster is generally secund, or more or less one-sided, and the bracts are longer than the flower-stalks. But the green bracts do not diminish to any great extent the brilliancy of the blood-red coloring which makes this plant perhaps the most showy of our smaller northern wild flowers.

The stems are from two to five feet high, and carry the scarlet clusters above the swamp-grasses where the plant abounds. With the background of dark-green alder leaves and with the somewhat paler green of the grass below, the scarlet flecks of the Cardinal-flower have formed favorite contrasts of color for many of our artists. It may be remembered that this startling contrast has been described by Dr. Holmes in some of his best-known lines:—

“The Cardinal, and the blood-red spots,
Its double in the stream;
As if some wounded eagle’s breast,
Slow throbbing o’er the plain,
Had left its airy path impressed
In drops of scarlet rain.”

The flowers sometimes are dark rose in color, or pale pink, or even white. In a living specimen received at the Botanic Garden from Professor Gibbs of Newport, the flowers were perfectly white. In another specimen some of the flowers were streaked with white while the rest were rosy rather than scarlet. Such variations are by no means so rare as usually thought. An attentive examination of the shades of hue in many of our wild flowers will bring to light in a single summer a large number of marked "sports" of color, and in some cases the varieties are well worth perpetuating.

The Cardinal-flower is perennial, and is readily cultivated in any rich, damp soil. It needs but little care, and may well be grown much more extensively as a decorative plant. With the nearly allied dark-blue species very effective combinations can be easily made.

The dark-green leaves are alternate, oblong-lanceolate, and somewhat coarsely and irregularly toothed. The upper leaves are much narrower.

The calyx-tube is adherent to the ovary, and is five-cleft at its border. The corolla is tubular, and is cleft nearly or quite to the base upon one side. The border of the tube is plainly two-lipped, the lower lip having three somewhat spreading lobes, and the upper lip two which are nearly erect.

The stamens are united by their anthers (*syngenesious*) and also by their filaments (*monadelphous*), forming a tube

which is inserted upon the summit of the ovary. Usually the filaments are slightly distinct below.

The anthers, two of which are tufted, surround the style. The latter bears near its end a collar of spreading bristles, which, as it elongates slowly after the flower has opened, push out as if upon a brush the pollen which the anther-cells contained. Having reached the end of the tube formed by the anthers, the style protrudes a little and its bilobed stigma expands. The Cardinal-flower is therefore a good illustration of proterandrous dichogamy, for the pollen of each flower has been shed and removed from the anthers before the stigma comes to maturity. This provision for preventing close-fertilization is found through the order *Lobeliaceæ*. Associated with it are adaptations for securing crossing, such as a supply of nectar secreted by the top of the ovary and advertised by the showy corolla.

Bees visit the flowers of most species of *Lobelia* for this nectar, and in getting it unconsciously carry pollen from one to another, thus effecting their cross-fertilization. The Cardinal-flower, however, has so long and narrow a corolla-tube that bees are unable to reach its nectar, which is, moreover, so watery that they do not in this case resort to their frequent expedient of biting through the corolla to get at it. They are replaced by our beautiful ruby-throated humming-bird, which may be seen where the plants are plentiful, gracefully poising itself before one flower after another, while its tongue deftly explores them and removes their sugared store; but

in doing this the bird is continually receiving pollen from the anthers of young flowers and leaving it upon the expanded stigmas of those which are older. This is one of the very few cases in which our native flowers are adapted to fertilization by humming-birds; but in tropical America, where these birds are more abundant, many flowers are exclusively cross-fertilized by them. Such flowers are sometimes spoken of as ornithophilous, or bird-loving.

The ovules are very numerous, and are anatropous. The ovary is two-celled, and at maturity forms a many-seeded, two-celled capsule which is two-valved, opening at the summit.

The whole plant is acrid, and has throughout a milky juice or latex, as have its nearest relatives, the allied Harebells on the one hand and certain *Compositæ* on the other.

The order *Lobeliaceæ* is now merged, as a sub-order, in the order *Campanulaceæ* (the Bell-flower family). Of the genus *Lobelia* there are about two hundred species, a few of which have been used in medicine. Of these the most widely known perhaps is the notorious quack medicine, *Lobelia inflata*, or Indian Tobacco. The name *Lobelia* commemorates De l'Obel, a Flemish botanist.



PLATE XLII.

PARTRIDGE-BERRY.

Mitchella repens, L.

THE name Partridge-berry has been also applied in many places, particularly in the Eastern States, to the Aromatic Wintergreen or Checkerberry (*Gaultheria procumbens*, L.), a plant which resembles *Mitchella* only in the color of the fruit. The two plants belong to different families, and the structure of the red fruit is different in the two. In *Gaultheria*, the so-called berry consists chiefly of the thickened, fleshy calyx, which envelops but is not adherent to the ovary within. The fruit of *Mitchella* is a double drupe, or stone fruit, each half of which contains four hard, seed-like nutlets. The differences throughout between the two plants are not greater, however, than exist between several other plants which have been called in popular language by the same trivial or common names. Thus the Tulip-tree (*Liriodendron*) receives the name of "Poplar" in the southern and some of the western states; *Aquilegia*, or Columbine, goes by the name of "Honeysuckle"; "Bittersweet" is the name given to the widely-separated plants *Solanum Dulcamara* and *Celastrus scandens*. The examples of misapplied common names are

numerous, and suggest by their number the desirability of securing in some way uniformity of nomenclature. It is not easy to see in what manner any change for the better can be brought about. In one of the best English Floras (Bentham's Handbook of the British Flora) a common name has been applied to each genus and species, in many cases the specific name being merely a translation of the scientific appellation.* The attempt to introduce a similar trivial, binomial nomenclature for our native plants is attended by very great difficulties, and is not at present practicable.

The smooth, trailing stems of the Partridge-berry have opposite shining, evergreen leaves. The leaves are roundish-ovate, have short petioles, and at their base minute stipules. The latter might be easily overlooked, but they constitute one of the most important characters of the order (*Rubiaceæ*) to which the plant belongs. That these stipules, now existing as the merest vestiges, subserve no useful purpose in the life of the plant at present is tolerably clear; but the persistence of such rudimentary organs gives them a high value as characters in the determination of affinities. Playing an unimportant part in the life and work of the plant, they have come down with comparatively little change in the long line of descent.

The flowers occur in pairs with the ovaries confluent into one. The corollas also are sometimes confluent, in which case the compound tube has an eight-lobed or ten-lobed border.

* *Cerastium arvense*, Field Cerast; *Bidens cernua*, Nodding Bidens.

Generally, however, the funnel-shaped corollas are distinct down to the ovary, and each has four spreading or recurved lobes. The lobes and the throat of the tube are thickly clothed with hairs, which almost close the orifice. The style is single, and has four divergent, filiform stigmas. In some of the flowers the style is long and the stigmas project, and below are the four included stamens; in others the positions are correlate to these, that is, the stigmas are within while the stamens are exerted. The relations of dimorphous flowers have been already adverted to when speaking of *Epigæa*, in which the blossoms are heteromorphous.

The ovaries are four-celled, each cell containing at its base an erect anatropous ovule. The united ovaries ripen into drupe-like, scarlet fruits, each having four hard nutlets. Before maturity the nutlets are soft, and the unripe covering would therefore not protect the seed within against the action of the alimentary canal of birds, if eaten by them. But when they are ripe, the hardened covering is not, to any great extent, affected by the gastric juices or even by the mechanical action of the digestive apparatus of birds, and they are voided with the vitality of the seeds uninjured, it may be at considerable distances from the place where the bird plucked and swallowed the fruit. In this connection it is to be observed that a very interesting correlation exists between the color of the fruit and its degree of ripeness. When ripe the fruit is of an attractive color, and is readily seen by birds; when unripe the color is not so readily discernible, and may

be called protective. Similar and even more striking instances of the relation of the color of fruits to their ripeness and to their fitness for being carried by birds for long distances can be found in many of our common native plants. The true Nightshade family and the Rose family afford some exceedingly beautiful examples.

The genus *Mitchella* belongs to the order *Rubiaceæ*, a family which comprises comparatively few plants in the cooler parts of North America, but which, from the number of species in warmer regions, is one of the largest known. Some of our most important plants are members of this family, notably Coffee and Cinchona.

The genus *Mitchella* itself has only two species hitherto described, one a native of North America, the other of Japan. A similar relation between the distribution of species is seen in *Epigæa*, the May-flower, which has likewise two species, one in North America and the other in Japan. The recital and comparison of such facts in distribution has been made by Professor Gray one of the most interesting chapters in the life-history of our native plants.

The name *Mitchella* was given by Linnæus in honor of his correspondent, Dr. John Mitchell of Virginia.



Drawn by Isaac Sprague

Plate XLVIII.

DUTCHMAN'S PIPE.

ARISTOLOCHIA SIPHO, L'HER.

Armstrong & Co. Lith.

PLATE XLIII.

DUTCHMAN'S PIPE.

Aristolochia Sipho, L'Heritier.

THIS is one of our most attractive twining plants. In rich soil along the Alleghany Mountains, and the ranges farther south, it clings to the trees and forms dense pendant masses of foliage, the stem at base often becoming a couple of inches in diameter, and the leaves more than a foot in breadth. Owing to the rich color and luxuriance of its foliage, it is prized as a decorative shrub for arbors, and for trellises shading walks. The leaves are alternate, reniform (kidney-shaped), with edges more or less wavy, and nearly smooth. In the axils are superposed buds which produce the flowers. It is not uncommon to find in the same axil two flowers, one a little more advanced in development than the other, and appearing to come from the same point. The flower-stalk has a clasping, heart-shaped bract.

The flower is a good illustration of a distinction which is made in descriptive botany between a *complete* and a *perfect* flower. A flower is technically said to be "perfect" when it possesses both the essential organs, namely, the stamens and

pistil: it is called, "complete," when it has all of the four whorls or floral circles. Dutchman's Pipe has stamens and a pistil, and is therefore *perfect*; but it has no corolla, and is therefore *incomplete*.

The calyx, which is the only floral envelope possessed by this flower, is tubular and curved much upon itself. At its middle part the bent tube is very noticeably inflated, but near its mouth is again much constricted, and here the border is flat and spreading. If the border is removed, the resemblance of the blossom to a Dutch pipe is very striking, and in some of the older flowers this is heightened by the rich brown color of the calyx-tube. The border or limb of the calyx is thin-lobed; the tube beneath is strongly nerved.

The six stamens have erect, sessile anthers, which are closely adnate to the stout stigma. The stigma is three-lobed. The ovary is inferior, and contains many ovules, which ripen into flat seeds; the ovary becoming a six-valved pod.

The genus *Aristolochia* comprises more than one hundred and fifty species, distributed chiefly throughout the tropics, and there exhibiting great diversity in the size and form of the calyx. In a few instances the flowers are of immense size. The color of the calyx ranges in the species from dull, greenish-yellow through purple to a deep brown; and in the larger-flowered the odor of the lurid blossoms is extremely fetid.

The fertilization of the flowers of *Aristolochia* has been studied in several species, and in these insect-agency has been observed. In the European species, *A. Clematitis*, the differ-

ence between the period of maturity of the stigmatic surface and of that of the anthers is very noticeable, the stigma being receptive before the pollen is discharged. An insect, a small fly for instance, coming to a flower in search of nectar, finds the open mouth of the calyx of this species unobstructed. Within the tube are hairs which point downward, and present no slight hindrance to the return of the insect. As a rule, the insect is completely barred in by the hairs, and when the anthers are ripe, his body soon becomes covered with pollen. Suppose, in the first case, that the insect comes in contact with the stigma, which perhaps may be still receptive: the fertilization of the ovules results, and the flower begins to wilt. With the wilting of the flower comes of course a wilting of the hairs, which have hitherto served as prison-bars, and the insect, with his body dusted with pollen, flies to another blossom. Here the opening is as free as before, and the entrance is easy, but the exit is impossible until the fertilization is effected. But in this second case the insect has brought pollen to a receptive stigma which is surrounded by anthers as yet unripe. And thus with pollen from another flower cross-fertilization is secured. The position of the calyx in this species is also changed at times which correspond to the proper period of inviting insect visitors, and of releasing them from their temporary imprisonment. What has been said of *Aristolochia Clematitis* is in a measure true of the other species, although the mechanism of retention is different, and in some there is a nearly unobstructed passage in and out.

But in all there appears to be an appreciable difference in the period of maturity of pollen and stigma. Some of the tropical species, as has been above noted, emit a fetid odor. This is believed to be correlated with the visits of carrion-feeding insects.



Drawn by Isaac Sprague

GROUND NUT.

Armstrong & Co. Lith.

Plate XLIV.

APIOS TUBEROSA, MOENCH

PLATE XLIV.

GROUND-NUT.

Apios tuberosa, Moench.

THE name "ground-nut" is applied in America also to *Aralia trifolia*, a pretty herb which bears a cluster of small flowers in spring, and which has a globular tuberous root deep in the rich mould. The name has been also given, but far less generally, to two other plants besides the one figured in the plate. *Apios tuberosa* bears esculent but rather tasteless tubers, which are the thickened extremities of underground branches. From the shape of the tubers, somewhat like that of pears, the name *apios* (from ἄπιον, a pear) is said to be derived.

The stem above ground is twining, and is generally tangled in the thickets where it grows, some of the leaf-stalks and of the younger shoots, by their curvature, aiding the plant to climb as well as twine. The alternate leaves have five to seven lanceolate leaflets, and these possess at base minute stipels (leaflet-stipules). The brownish-purple flowers are clustered in rather compact axillary racemes, which differ considerably in the number of flowers which

they contain. The flowers resemble in their general shape those of the leguminous plant already examined in this work (*Psoralea*, p. 95). The calyx appears to consist of a long, sharply-pointed tooth below, and of two shorter ones above; but there are also two lateral rudimentary ones. The standard, or upper petal, is very wide, and strongly turned back; the wings are shorter than the standard, and are adherent to the two lower petals, which constitute the *carina*, or keel. The keel is long and curved upward, and later is turned or coiled toward one side.

The stamens are in two sets: nine are united together; the tenth, nearest the standard, is distinct. The style is curved upward, and has no beard upon the upper side. The ovary is almost straight, and ripens into a long pod containing many seeds.

The fertilization of this interesting plant has been fully described by Professor Gray, in the *American Agriculturist* for January, 1877. From his account the following is taken: "The weight of a bee alighting on the wing-petals does not alter the position of the stamens and pistil at all. The tip of the curved keel rests firmly in a small notch or indentation at the middle of the top of the standard. The keel remains fixed in this way, if the flower is let alone, spanning across the middle of the deep cavity which opens to the bottom of the flower. The tip of the keel is not dislodged from its socket by any moderate jar, nor by pressure from the outside. But when, in any fresh

flower, we lift the tip by the point of a pencil from underneath, the keel promptly curves more, and splits from the apex down the inner edge, protruding the tip of the style, and, in a less degree, the opening and pollen-laden anthers.

"How this contrivance subserves cross-fertilization, it is easy to see. The anthers, from the first, lie a little behind the stigma, which is small, and at the very tip of the naked style. At first, the stigma is covered with a pulpy secretion; at last, when the stigma develops fully, and the centre is free from this pulpy matter, this forms a soft ring around its base, over or through which no pollen passes. Nor is it likely that any pollen reaches the stigma when this and the anthers protrude upon liberation from their confinement. This liberation ordinarily takes place only upon the visit of a bee, or some such insect, which entering, at least partially, into the open cavity of the blossom either side of the keel, presses the latter upward from beneath.

"The strong tendency to further curvature of the whole keel, and especially of the pistil, which before simply pressed the tip into its socket, and so held all fast, now takes effect, and it coils closely. During this coiling, the stigma and then the anthers are likely to be brought into contact with some part of the insect's body; and so, when flower after flower is visited, cross-fertilization must needs be effected. Equally, too, when a bee visits a blossom which has been let loose, if it enters upon the side toward which the style swerves (as it always at length, if not immediately, does,

either to right or left), the stigma will first be touched, probably by a pollen-dusted portion of the insect's body, and then the anthers will give a new supply of pollen for the next blossom; and so on."

The plant for which this might be most readily mistaken is a species of wild bean, *Phaseolus perennis*. The latter has, however, smaller flowers, and leaflets in threes, instead of fives or sevens. Moreover, in the latter the clusters are much less compact. *Apios tuberosa* grows in wet grounds, blooming in August and September.

There are three species of the genus *Apios*; one is found in the Himalaya, another in China, the third being the one figured in our plate.



Drawn by Isaac Sprague

Plate XLV.

PICKEREL WEED.

PONTEDERIA CORDATA, L.

Armstrong & Co. Lith.

PLATE XLV.

PICKEREL-WEED.

Pontederia cordata, L.

OF the plants thus far delineated in these plates, the lily, page 25, is perhaps the most nearly allied to *Pontederia*. In general it may be said that they are both monocotyledonous, and have a free or superior ovary, a compound pistil, a colored perianth of six parts, and six stamens. They differ, however, in the character of the stamens; in the former the six stamens are all fully formed and have perfect anthers; in *Pontederia* the six stamens are in two sets of three each, the three posterior or upper with short filaments, the three anterior or inferior on long filaments. To this difference may be added also the characters of the ovary; in the former the ovary is three-celled with many ovules; in the latter the three-celled ovary has two empty cells, and ripens only one seed.

The perianth is tubular and bilabiate; the lower lip is composed of the three spreading lobes, which are hardly joined except at the base; the upper is formed of three

united lobes. At maturity the fleshy base of the perianth surrounds the ovary (the utricle); in a near relative the perianth disappears at an early period.

The flowers are clustered in a fleshy compound spike, which is partly surrounded at base by a conspicuous bract. The flower-stalk has also midway a clasping leaf of the same shape as the other leaves of the plant. These are heart-shaped or arrow-shaped, and of considerable thickness. In one variety the blades are nearly lanceolate, and have hardly any projections at base.

The fertilization of this plant has been carefully studied by Mr. W. H. Leggett.* He finds that "*Pontederia cordata* is as truly trimorphic as *Lythrum Salicaria*, or even more so. There are three kinds of flowers not on the same but on different plants. Of these one has the stigma raised on the style to the top of the flower, a second only to the middle of the flower or top of the tube, and the third with a very short style at the bottom of the tube. There are thus three positions for the stigma. Whenever the stigma is in one of these positions the two others are occupied respectively by one of the two sets of anthers, three in a set. When the anthers occupy the highest position their pollen is about $1\frac{1}{2}$ thousandths of an inch in diameter. Anthers occupying the middle positions have pollen rather smaller, say $1\frac{1}{4}$ thousandths of an inch in diameter. When at the bottom of the tube the anthers have still smaller pollen,

* Bulletin Torrey Botanical Club, Vol. VI., p. 170.

say one-thousandth of an inch or less. The pollen in all positions seems perfect."*

Pickereel-weed is very common on the borders of ponds and lakes, and blooms in July to September.

* For a description of Dimorphism, see page 158 of this work.



PLATE XLVI.

ARROW-HEAD.

Sagittaria variabilis, Engelmänn.

BOTH the common and the scientific name are descriptive of the ordinary form of leaves met with in this genus. The blades of the leaves are generally sagittate, and are borne upon long petioles, which are like slender shafts of arrows. In some varieties the leaf-blade is halberd-formed; that is, the barbs of the weapon are distinctly turned outward; in a few others the blade is lanceolate, or even linear; while in others still it is rudimentary, and the leaf is represented only by a flattened petiole (phyllodium). Nor do the varieties of shape end here: in a few forms the tip of the leaf is obtuse instead of acute, as in the cases above mentioned, and the blade may be even oval. The diversities of texture are almost as great as those of form; ranging from the most loose and even spongy to a firm and almost leathery tissue. In veining the leaf-blades are somewhat netted, having distinct nerves or strong veins, and cross veinlets between. This plant is monocotyledonous like the *Lilium* and *Cypripedium* described on pages 25 and 53, but the leaves are more

or less distinctly reticulated. As a rule, monocotyledonous plants have leaves with parallel veins. The present case is therefore intermediate between the venation of *Arisœma* (p. 123) and that of the plants above mentioned. The leaf-stalks are clasping at base, and through the sheathing bases rises the flower-stalk or scape. This bears a loose cluster of white flowers arranged in threes, some containing only stamens while others have only carpels (the pistil). As a rule, the staminate and fertile flowers occur on the same scape (*monœcious*), but in a few instances these are found on separate plants (*diœcious*). In one species, at least, perfect flowers are found together with the imperfect (*polygamous*). The perianth consists of a calyx and corolla, each of three parts, while it will be remembered that in most monocotyledons (see *Lilium*, etc.,) there is no such plain distinction in the floral envelopes.

The sepals in *Sagittaria* are green and persistent, the petals are white and fall early.

The stamens are numerous; the carpels are also numerous, and are clustered into a globose mass, flattened somewhat at the summit. The carpels ripen into one-seeded fruits, which are membranaceous and more or less conspicuously winged, and which do not open when ripe (*achenia*).

The species here figured is one of the most variable, presenting many well-marked forms, and therefore meriting its specific name, *variabilis*.



Drawn by Isaac Sprague

WHITE BAY

GORDONIA PUBESCENS, V. HER.

PLATE XLVII.

FRANKLINIA, OR WHITE BAY.

Gordonia pubescens, L'Heritier.

OF two names which the tea family has received, *Camelliaceae* and *Ternstroemiaceae*, Professor Gray prefers, and has adopted for his Manual of Botany, the former. For our present purpose the first name is the better, inasmuch as the *Camellia*, which is taken as the type, is a nearer relative of *Gordonia* than is *Ternstroemia*, a tropical genus, from which the latter name comes.

The order contains over two hundred and fifty species of trees and shrubs, a few of which latter are climbing. The plants are found chiefly in tropical regions and in the warmer parts of the temperate zone. The genus best known is *Camellia*, which affords some of the most attractive plants known to cultivation. The superb varieties have long been favorites, and appear still to retain in good measure their hold upon the public.

The species of tea are now generally referred to the genus *Camellia*, although they have been placed by some in a distinct genus, *Thea*.

The general characters of the well-known Camellias of the conservatory are almost precisely those of *Gordonia*.

The thick, glossy leaves are alternate and simple; the showy flowers are complete; the calyx of five or six sepals of unequal size, and often grading into bracts below; the corolla of five petals somewhat slightly cohering at base; stamens numerous and pentadelphous, one cluster clinging to the base of each petal.

The anthers of *Gordonia* are versatile; that is, they are poised by their connective, or part which connects the anther-cells, upon the top of the filament. Extrorse anthers are those which face outwards from the axis; introrse face inwards.

The style is single; ovary three to five-celled, with 2-8 pendulous ovules in each cell. The ovary ripens into a four or five-valved pod, which is of woody texture; and at maturity the valves separate from the axis.

The flowers "open in succession during two or three months, and begin to appear when the tree is only three or four feet high."

The two species of *Gordonia*, *G. Lasianthus* and *pubescens*, have been long known in cultivation; the former is perhaps a little less tolerant of cold than the latter. *G. Lasianthus* is known as Loblolly Bay, and grows abundantly in the swamps here and there found throughout the pine barrens of the South, forming the so-called "Bay Swamps." The species figured in the plate is smaller than the true Loblolly

Bay, but has larger flowers, and has a spherical capsule, while the fruit of the latter is somewhat cone-shaped. It was thought by Bartram to be a distinct genus, and he proposed for it the name *Franklinia*. The word has been kept in Michaux and Nuttall's *Sylva* as the popular name of the plant, and may well serve to distinguish the plant from the more widely-known species.

"The *Franklinia* blooms in Carolina about the beginning of July, and a month later near Philadelphia." *

* *Michaux and Nuttall. Sylva Americana, Vol. II., 21, 22.*



Drawn by Isaac Sprague

Armstrong & Co. Lith.

Plate XLIII.

AMSONIA TABERNAEMONTANA, WALT.

PLATE XLVIII.

AMSONIA.

Amsonia Tabernæmontana, Walter.

Two families of our native plants are peculiar in the mode in which their carpels are united. In general, if the carpels are joined at all it is at their base or else throughout; but in the orders *Asclepiadaceæ* and *Apocynaceæ* the ovaries are distinct, except that the carpels at their upper part are confluent to form one style and stigma. To the latter of these orders *Amsonia* belongs.

The two ovaries have many ovules two-ranked in each, and ripen into long and rather delicate erect follicles containing roundish or cylindrical seeds, which are packed into one row and flattened above and below by mutual compression. The seeds are naked. In the near relatives the seeds are furnished with a coma or tuft of down. The stigma has at its edge a reflexed membrane.

The stamens are five, and are inserted on the tube of the corolla, beyond which they do not protrude. The anthers are longer than the filaments, and are blunt at each end.

The tube of the corolla is slender, and dilated some-

what near the stamens, the border having five linear lobes. The throat of the corolla is thickly bearded, but has no scales. In an allied genus *Apocynum*, or Dogbane, the throat of the corolla has five triangular scale-like appendages.

The calyx is five-parted, and has short, narrow, acuminate segments, but possesses no glands at the base inside like the genus *Forsteronia*.

The pale-blue or almost lead-colored flowers are arranged in panicle-like clusters, which are terminal, and in their development are true cymes.

The erect stems are about two feet in height, and have thin alternate lanceolate entire leaves, which are acute or acuminate at apex and somewhat rounded below.

The order *Apocynaceæ* contains about nine hundred species belonging to one hundred genera. Of these genera, the following are best known in cultivation: *Oleander*, *Vinca*, the common Periwinkle, also often improperly called Myrtle, and *Alamanda*. The genus *Amsonia* has four species, all of them belonging to North America or Japan. *Amsonia Tabernæmontana* is found in damp grounds south and west, and can be readily cultivated with little care.

Tabernæmontana, here used as a specific name, is the name also of a large tropical genus widely dispersed.



Drawn by Isaac Sprague

SAND MYRTLE.

Armstrong & Co. Lith.

Plate XLIX.

LEIOPHYLLUM BUXIFOLIUM, ELL.

PLATE XLIX.

SAND MYRTLE.

Leiophyllum buxifolium, Elliott.

FROM the pine-barrens of New Jersey this plant ranges far southward, chiefly along the mountains. The stems are less than a foot high, and thickly branched throughout, giving to the shrub a tufted appearance. The many branches are closely covered with shining, evergreen leaves, so that even when out of flower the plant is far from being unattractive. When, however, the compact mass of smooth foliage is relieved in May and early June by very numerous clusters of white and rosy flowers, it may be regarded as one of our prettiest native plants. The flowers are arranged in terminal cymes, which have at their base thick and persistent bud-scales.

The calyx is five-parted. The corolla is made up of five distinct oblong petals, often obovate, and more or less spreading. The ten stamens have exserted anthers, which open not by terminal pores, as is the case with so many of the near relatives of this plant, but by longitudinal slits. (Compare *Rhododendron* or *Azalea*, page 151, and *Clethra*, p. 103.)

The ovary is two-celled or three-celled, and when ripe is a capsule which breaks open at the apex. The seeds are numerous.

In many respects this beautiful plant resembles a European member of the same order, which is abundant upon the summits of the White Mountains, *Loiseleuria procumbens*, Desv., formerly called *Azalea procumbens*, L.

The latter is rather lower, has smaller leaves, and fewer flowers in each cluster. Moreover, it has a monopetalous corolla and only five stamens.

The common and the scientific names of this plant alike have reference to the smooth and thickish leaves. The true Myrtle (*Myrtus communis*), a large shrub or tree growing in Southern Europe, has been widely known from the use formerly made of the leaves for decorative purposes in certain ceremonies. Hence it is not strange that other plants sharing with the myrtle only some of the more distinctive characters of foliage should have received in popular parlance the same name. For instance, common Periwinkle, *Vinca*, is more generally known under the name of Myrtle, but has nothing in common with it save the smooth and evergreen leaves. The scientific name, *Leiophyllum*, is from the Greek *λεῖος*, smooth, and *φύλλον*, leaf; *buxifolium* refers, of course, to the ordinary *Buxus*, or box, to which our plant bears a resemblance in miniature.



Drawn by Isaac Sprague

PITCHER PLANT.

Armstrong & Co.

Plate L.

SARRACENIA PURPUREA, L.

PLATE L.

PURPLE PITCHER-PLANT.

Sarracenia purpurea, L.

OUR peat-bogs offer to the botanist many exceedingly interesting plants, some of which are by no means attractive to a casual passer-by, but the swamps shelter also a few plants of much beauty. Two of these have already been spoken of in the earlier pages of this work; another, far more grotesque in form of leaf and structure of blossom, is now added.

The common pitcher-plant of the cooler American peat-bogs is the one figured in the plate.

Its pitcher-shaped or urn-formed leaves spring from an underground stem, and are clustered thickly in a mass, amid which rise a few single-flowered scapes. The tubular leaves have upon the side of the pitcher a wing, which is where the handle of a ewer would be, so that only a foot or stand is wanting to complete the rude resemblance from which the popular name comes. The outside of the pitcher is usually strongly veined with red or purplish lines, but these are sometimes wholly wanting. The nodding flowers are complete. Below the calyx, and looking much like one, is a whorl of

three colored bractlets. The calyx consists of five persistent colored sepals; the corolla of five obovate brownish-purple petals. The stamens are many, inserted on the receptacle, and distinct from each other. Their anthers are versatile and two-celled.

The pistil consists of five carpels united to form a five-celled ovary. It sometimes happens that the partition-walls, by which the ovary is made three or five-celled, do not reach to the summit of the ovary; consequently, a section near the top might lead to the mistake of regarding the ovary as one-celled. By a reference to the diagrams on page 86, it will be seen that both *Arethusa* and *Calopogon* have one-celled ovaries, but that *Lilium* is distinctly three-celled. At the same time it will be noticed that the three placentæ in *Calopogon* come so close together in the axis that the ovary might be thought, at first glance, to be three-celled. By a slight error in engraving, the ovary of *Cypripedium* is not clearly enough shown to be one-celled.

The style of *Sarracenia* is dilated at the summit into a shield-shaped body, which has five angles and five slender nerves radiating to them. At their delicate extremities these are stigmatic below, and are somewhat curved or hooked.

The leaves of nearly all the species of *Sarracenia** deserve the name of pitchers, although at a pretty late stage of their development those of some kinds are scarcely if at all tubular.

*The leaves of some other genera are also pitcher-form, notably those of *Nepenthes* and *Cephalotus*.

In the case of our Northern plant the use of the pitchers is by no means clear, but some light is thrown upon the subject by an examination of the species found at the South. In a series of short notes in the American Journal for Science and Arts, for 1873 and 1874, Dr. Gray has given an account of the early and some of the later investigations as to the end which the pitchers probably subserve. From these notes it appears that Dr. James Macbride, of South Carolina, called attention to the subject in 1815.*

Elliot, in calling attention to this paper on *S. adunca*, or *variolaris*, says:—

“It may be sufficient here to remark that the throat or orifice of these leaves is generally covered with a saccharine secretion, or exudation. Immediately below the throat, for the space of nearly an inch, the surface is highly polished, while the lower part of the tube is covered with hairs all pointing downward. When an insect, attracted in the first instance by the secretion of the plant, or perhaps even by the water, descends, as it can easily do along this declining pubescence, it appears incapable of ascending by its feet alone, and can only escape by a flight so perpendicular as to surpass the power of most insects. Whenever they touch the bristly sides of the tube they are precipitated again to the bottom, and have to renew their efforts; and many insects, even of a large size, perish in this arduous and hopeless struggle.”

* On the power of *Sarracenia adunca* to entrap insects, in a letter to Sir James E. Smith, read Dec. 19, 1815. Published in Trans. Linn. Soc., XII., p. 48 (1818).

An observer, quoted by Dr. Gray, in the same series of notes, says of the pitchers of *S. flava*: "These, brought into the house, and kept fresh by the immersion of the base in water, showed the saccharine secretion most abundantly about a quarter of an inch above the junction of the lid with the rim." . . . "Many flies settled on the lids, and feasted on the saccharine narcotic. Evident signs of intoxication were manifested in each case by their breaking loose repeatedly before tumbling into the gulfs."

Dr. Gray gives in the Journal, for June, 1874, an outline of a communication received from Dr. Mellichamp, of North Carolina, respecting the capture of insects by one of the Southern species of *Sarracenia*; *S. flava*. A sugary secretion appears within the rim of the tube, moistening it all the way round, and extending a short distance down the pitcher. "This sweet secretion is continued externally in a line along the edge of the wing of the pitchers down to the petiole, or to the ground, forming a honeyed trail or pathway up which some insects, and especially ants, travel to the more copious feeding-ground above, whence they are precipitated into the well beneath." . . . "As to the supposed intoxicating properties of this secretion, Dr. Mellichamp was unable to find any evidence of it. On cutting off the summit of the pitchers, and exposing them freely to flies in his house, he found that the insects which came to them and fed upon the sweet matter with avidity, flew away after sipping their fill, to all appearances unharmed. On the other hand, he

thinks that the watery liquid in which the insects are drowned and macerated possesses anæsthetic properties; that house-flies after brief immersion in it, and when permitted to walk about in a thin layer of it, were invariably killed—as at first supposed—or, at any rate, stupefied or paralyzed in from half a minute to three or five minutes, but most of them would revive very gradually in the course of an hour or so.”

That the decomposed insects in the tubes can contribute to the nourishment of the plant is rendered highly probable by experiments which have been performed upon the other sorts of pitcher-plants referred to on a previous page. Purple pitcher-plant has been employed to some extent as a remedial agent in small-pox, but its use has not been attended with very marked results. The generic name commemorates Dr. Sarrazin, of Quebec.

The best description of the microscopic structure of the pitcher of the Northern *Sarracenia* is by Schimper, in *Botanische Zeitung*, April, 1882.

INDEX.

- | | | |
|---|--|---|
| <p>Acaulescent, 53
 Achenia, 192
 Achenium, 65
 Adherent ovary, 32-55
 Adlumia cirrhosa, Raf., 67
 Agave, 165
 Alæ, 96
 Amaryllidaceæ, 165
 Amsonia, 197
 Anatropous, 65, 142
 Ancipitous, 89
 Andræcium, 7
 Androgynous, 124
 Anther, 7
 Apetalous, 65, 141
 Apios tuberosa, 183
 Apocynum, 198
 Aquilegia Canadensis, 1
 Arbutus, 155
 Arethusa bulbosa, 85
 Aril, 83
 Arisæma, 123
 Aristolochia Clematitis, 181
 Aristolochia Siphon, 179
 Arrow-head, 191
 Arrow-leaved Violet, 37
 Aster longifolius, Lamarck, 49
 Aster undulatus, L., 21
 Aster (wavy-leaved), 21
 Attraction in fruits, 177
 Axillary, 155</p> | <p>Azalea, 151
 Bast-fibres, 161
 Bellwort, 81
 Bidens, 131
 Biennial, 69
 Blood-root, 141
 Blue Flag, 31
 Bread-root, 97
 Bulb, 26
 Bulbiform Embryo, 118
 Bur-marigold, 131
 Cacalia, 78
 Caducous, 141
 Calla, 117
 Callirrhoe, 113
 Calopogon, 73
 Calyx, 7
 Calyx-tube, 147
 Camellia, 193
 Camelliaceæ, 193
 "Canada Thistle," 138
 Cardinal-flower, 171
 Carina, 96
 Carpels, 7, 163
 Carrion insects, and
 Symplocarpus, 120
 Centrifugal inflorescence, 50
 Centripetal inflorescence, 50
 Chaff, 44
 Checkerberry, 175
 Cherokee Rose, 149</p> | <p>Chickweed-Wintergreen, 47
 Chlorosis, 149
 Chorisis, 68
 Cinchona, 178
 Cineraria, 78
 Cirsium pumilum, Sp., 39
 Cleistogamous flowers, 42
 Clematis, 61
 Clethra alnifolia, 101
 Climbing fumitory, 67
 Cnicus pumilus, Torrey, 138
 Cochleate, 136
 Coffee, 178
 Columbine, 1
 Column, 54
 Coma, 197
 Complete, 7, 179
 Compositæ, 22
 Cone-flower, 43, 111
 Connate, 132
 Coreopsis, 132
 Coriaceous, 83
 Corm, 75
 Corolla, 7
 Corymbs, 89
 Cranesbill, 15
 Crowfoot family, 1
 Cyme, 77
 Cypripedium acaule, 53
 Daffodil, 165
 Dahlia, 132</p> |
|---|--|---|

- Dasystoma pubescens*, Benth., 9
 Deduplication, 114
 Definite inflorescence, 50
 Dehiscence of anthers, 26
 Dehiscence of fruits, 103
 Diagrams, 86
Dicentra, 67
 Dichogamy, 173
 Dicotyledons, 161
 Disk-flowers, 22
 Dissemination in *Viola*, 41
 Dimorphism cleistogamous, 127.
 Dimorphous, 127, 158
 Dioecious, 192
 Dodecatheon, 4
 Drupe, 175
 "Dusty Miller," 78
 Dutchman's Pipe, 179
 Echinacea, 111
 Endogenous, 161
 Ephemeral, 128
 Epidermis, 156
Epilobium, 106
 Equitant leaves, 32
 Ericaceæ, 101
Erodium, structure of fruit, 17
Epigæa repens, 155
 Essential organs, 7
 Evening Primrose, 106
 Exogenous, 161
 Extrorse, 194
 "Falls" in *Iris*, 32
 Farinaceous, 125
 Featherfoil, 47
 Female flowers, 65
 Fertilization of Orchids, 56
 Figwort family, 9
 Filament, 7
 Fire-weed, 106
 Flower-de-Luce, 31
 Flower, description of parts of, 7
 Flower, morphology of, 6
 Foramen, 166
Forsteronia, 198
 Foxglove (Downy False), 9
Franklinia, 193
 Free ovary, 26
 Frost-weed, 129
Fuchsia, 106
 Funiculus, 65
 Gamopetalous, 113
Gaultheria procumbens, 175
Gaura, 105
Gentiana crinita, 93
Gentian, 93
 German Ivy, 78
Geranium, fertilization of, 19
Geranium maculatum, 15
Gerardia flava, L., 9
Gerardia (slender), 9
Gerardia tenuifolia, Vahl, 9
 Glauous, 89
 Golden-rod, 167
 Golden Senecio, 77
 Ground Laurel, 156
 Ground nut, 183
 Groundsel, 78
 Halberd-form, 38, 191
Helianthemum, 127
 Hempweed, 145
 Heteromorphous, 158
 Honeysuckle, 154
Hottonia, 47
 Humming-birds and Cardinal Flower, 173
 Hybrid, 151
 Hybridization, 152
Hypoxis erecta, 165
 Indefinite inflorescence, 51
 Indehiscent, 96
 Indian Tobacco, 174
 Indian Turnip, 123
 Inflorescence, 50, 51
 Internodes, 61
 Introrse, 194
 Involucre, 23
 Involute, 45
Iris versicolor, 31
 Jack-in-the-Pulpit, 123
 Japanese plants, 178
 Jonquil, 165
Kalmia glauca, 89
 Labellum, 54
Ladanum, 129
 "Lamb-kill," 90
 Latex, 143
 Laurel, 89
 Legume, 96
 Leguminosae, 95
Leiophyllum, 199
Lepachys, 44, 111
 Lilies of America, 27
Lilium Philadelphicum, L.
 Lily-bulb. A store-house of food, 27
 Lily (Wild Orange-red), 25
 Limb, or border, 93
Lobelia cardinalis, 171
 Loblolly Bay, 194
 Loculicidal, 103
Loiseleuria, 154
 Loose-strife, 45
Lysimachia lanceolata, Walt.
 Male flowers, 64
 Malvaceæ, 113
 May-flower, 155
 Meadow-beauty, 135
 Melastomaceæ, 135
 Metamorphosis, 148
 Micropyle, 166
Mikania scandens, 145
Mitchella repens, 175

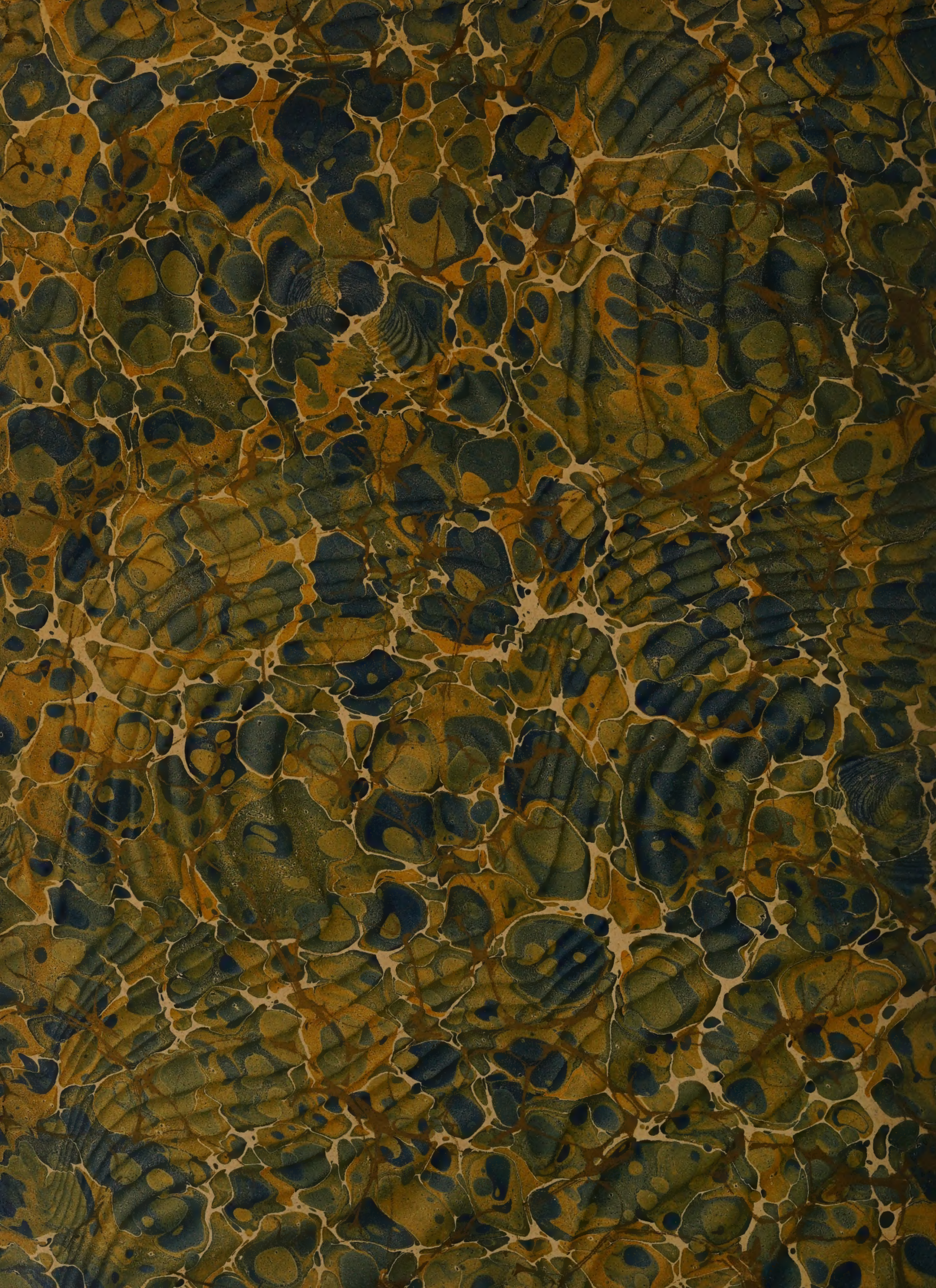
- Mixed inflorescence, 51
 Moccason flower, 53
 Monadelphous, 113
 Monocotyledons, 161
 Monœcious, 192
 Morphology, 73
 Mountain fringe, 67
 Myrtle, 200
 Narcissus, 165
 Nectar, 2, 3
 Nerves, 168, 191
 Neutral flowers, 43
 Nymphaea odorata, 161
 Oakes, William, 83
 Oakesia sessilifolia, 81
 Oleander, 198
 Onagraceæ, 106
 One-celled anthers, 115
 Ornithophilous, 174
 Orris-root, 35
 Orthotropous, 118
 Ovary, 7
 Ovule, 7
 Panicle, 70
 Papaveraceæ, 67
 Papilionaceous, 95
 Pappus, 24
 Parasites, 11
 Parasitism, Double, 12
 Parietal, 68
 Partial petioles, 61
 Partridge-berry, 175
 Pelargonium, 20
 Perfect, 179
 Perfoliate, 81
 Perianth, 25
 Periwinkle, 198
 Petals, 7
 Placentæ, 68
 Pollen, 7
 Pollen-masses, 74
 Polygamous, 192
 Polygams-dicecious, 64
 Pomme blanche, 95
 Pontederia cordata, 187
 Poppies, 67
 Popular names, 175
 Prairie Rose, 149
 Prickles, 150
 Primrose family, 45
 Primula, 47
 Primulaceæ, 45
 Prolification, 149
 Protective fruits, 177
 Proterogynous, 118
 Phylla, 25
 Phyllodium, 191
 Pickerel-weed, 187
 Pinxter-flower, 154
 Pistil, 7
 Psoralea esculenta, 95
 Puccoon, 143
 Pubescence, 102
 Racemes, 102
 Radical leaves, 53
 Rafinesque, 70
 Ray-flowers, 22
 Receptacle, 22, 23, 43
 Receptacular-tube, 147
 Regular flower, 7
 Reniform, 179
 Replum, 142
 Rhexia, 135
 Rhizoma, 31
 Rhododendron, 151
 Rhodora, 151
 Rock-rose, 127
 Rosa Carolina, 147
 Rose, 147
 Roses in History, 147
 Rubiaceæ, 176
 Rudbeckia columnaris, D.
 Don, 43
 Sagittaria variabilis, 191
 Sand myrtle, 199
 Sanguinaria Canadensis, 141
 Scape, 53
 Schizocodon, 108
 "Scotch Thistle," 139
 Secund, 171
 Senecio aureus, L., 77
 Sepals, 7
 Septa, 91
 Shooting-star, 47
 Shortia, 107
 Silique, 69
 Skunk Cabbage, 119
 Slender Gerardia, 9
 Snow-flake, 165
 Solidago, 167
 Spadix, 117
 Spathe, 117
 Sphagnum, 88
 Sports of color, 172
 Spoonwood, 91
 Spur of violets, 38
 Staminodia, 45
 Star-grass, 165
 Steironema lanceolatum,
 Gray, 45
 Stigma, 7
 Stigma in Iris, 34
 Stipe, 93
 Stipels, 183, 185
 Stomata, 162
 Strawberry-tree, 155
 Style, 7
 Swamp-rose, 147
 Symplocarpus, 117
 Syngenesious, 172
 Ternstroemia, 193
 Ternstroemiaceæ, 193
 Thea, 193
 Thistle, 138
 Thorns, 150
 Trailing Arbutus, 155

Trientalis, 47
Trimorphous, 158
Uvularia sessilifolia, 81
Ventral sutures, 163
Versatile, 194
Vertical leaves, 31

Vestiges of organs, 176
Vexillum, 96
Victoria regia, 163
Viola sagittata, 37
Violet, Sweet white, 99
Water-lily, 161

Wild Columbine, 1
Wild Honeysuckle, 151
Wintergreen, 175
White Alder, 101
White Bay, 193





Folio 455		Goodal	
G61 W		The w1	
SEP 7	1920	Other	
MAY 3	1921	MAY 3	
FEB 4	1925	Prof	
APR 16	1935	JKE	
MAY 16	1939	For	

